James Rowland Angell, 1869-1949, Psychologist-Educator

Walter Miles, *Yale University*

JAMES ROWLAND ANGELL made substantial and brilliant contributions to the science, education, and culture of his time. What he did and the influence he exerted, not only in the United States but internationally, are part and parcel of our most cherished achievements of the last half-century. He went all out for man. With clear vision, he saw that human progress and development lay along the road of research and cooperation. A master in the scientific study of the mind and of human behavior, he sought by lucid, analytical writing; by entertaining, summarizing addresses; and by wise administrations to realize on the implications of scientific research for the improvement of human living and achievement. He was an opener of the mind's eye. His salty Yankee comment both stimulated and challenged all who heard his dry voice, and left enduring traces in their memories. He never overreached himself; his points and objectives were not hazy or chimerical; his readers and auditors were not left with a flat or helpless feeling, but rather with hope and determination. In several different capacities, he exercised what must be accounted great administrative authority, but he did not push people around, or wave a big stick. He was companion, friend, teacher, and leader, and understood not only human foibles and frailties, but how to energize human capacities, power, and strength.

Jim Angell was born in Burlington, Vermont May 8, 1869, the youngest of three children. His mother, Sarah Swope Caswell, was a descendant of Peregrin White, of Mayflower fame. His brother, Alexis Caswell, twelve years older, became a judge on the federal bench. His sister, Lois Thompson, six years older, became the wife of an historian, Andrew C. McLaughlin. When Jim was born, his father, James Burrill Angell, was president of the University of Vermont. He had formerly been professor of modern languages at Brown University, and editor of the *Providence Journal* for six years. Subsequently he was the distinguished president of the University of Michigan for 38 years. In the latter academic household and community Angell grew up. It is not without interest to note that John Dewey, who greatly influenced Angell's early scientific outlook and professional life, was also born in Burlington, Vermont and was ten years his senior. Choice hereditary and environmental factors were not lacking and there was a virile religious family background. Jim's health was impaired by recurrent attacks of malaria, and by scarlet fever, which produced deafness in one ear. In his home he had a large amount of adult association: with his parents, the academic community, and many distinguished visitors. Among the latter he has recalled Cannon Farrar, Matthew Arnold, Andrew White, and Grover Cleveland. In his biography he says, "I was practically on my own, for my brother and sister were too much my elders to be companions in any intimate sense" (*2*).

After graduating from public school and starting high school in Ann Arbor, he spent a year and one-half in China, where his father had been sent as United States Minister. Jim, having completed high school, entered the University of Michigan and received his B.A. in 1890, and his M.A. in '91. As an undergraduate at Michigan, Angell's intellectual interests seem to have been aroused first by the study of Greek and then more especially by philosophy and psychology. The latter was under John Dewey, who had recently published a psychology text. Williston Hough taught him British philosophy, and with James H. Tufts he studied the general history of philosophy. The climax of his Michigan experience was a seminar with Dewey on William James' recently published *Principles of psychology*. Angell has said that this book, more than any other, profoundly influenced his thinking for the next twenty years of his life.

Fresh from this stimulating graduate year at Michigan, and on the recommendation of Dewey, he went, in the fall of 1891, to the Graduate School at Harvard, and studied under James, Royce, and Palmer. Taught and stimulated by this remarkable faculty, he was yet undecided whether to follow philosophy or psychology. After taking his M.A. at Harvard in '92, he went to Europe, as so many of the brilliant graduate students of his period did. Finding Wundt's laboratory at Leipzig full, he spent his first semester at the University of Berlin, where Ebbinghaus was lecturing on psychology and Paulsen on ethics. Also he occasionally audited the lectures of Helmholtz and other eminent scholars there. The second semester was spent at Halle under Erdmann in psychology and with Vaihinger on the philosophy of Kant. Angell became a candidate for the doctor's degree and wrote

a thesis on "The Treatment of Freedom in Kant's *Critique of Pure Reason* Compared with the *Critique of Practical Reason.*" His thesis had been accepted and returned for revisions when he received an offer to become instructor in philosophy and psychology at the University of Minnesota. Accepting this offer meant immediate departure for America. Revision of his thesis was consequently put off, and he did not receive his degree from Berlin then or later.

In beginning his work as a teacher, as a laboratory organizer and director, and as a research worker, Angell was singularly fortunate in his choice of positions. Moreover, he entered the field of psychology at its most formative period and when only eight American institutions had ventured to open laboratories. In the period 1890–1892, that is, between his senior year at Michigan and his M.A. at Harvard, twelve new psychological laboratories were started. These included Michigan and Yale, but not Minnesota or Chicago, both of which awaited Angell's advent. His record as a student at Michigan and at Harvard was highly recommendatory to him. He knew, had studied with, and was favorably known by men who were already leaders or later became leaders. The American Psychological Association, organized in 1892, elected him to membership the following year, at the age of 24. His name was starred in the first edition of *American men of science,* 1906, the same year he was president of the American Psychological Association. His reputation as a teacher, as a researcher, and as a research director grew rapidly, on a solid foundation of keen scientific insight and steady, devoted application to work. Frank Angell, the noted older psychologist of Stanford University, was his cousin. And although it may be said that Jim's academic background and connections may have tugged at his bootstraps, he was certainly not lacking in energy, drive, or headwork. He produced abundantly and in good quality, and graduate students were attracted from all over the country.

Only one year was spent in a vigorous workout at Minnesota—arranging and teaching courses, building up a psychological laboratory, and introducing a course in laboratory methods. Students and faculty associates alike were pleased and stimulated by these developments, which were aided materially by the chairman of the Department of Philosophy and Psychology there, Williston Hough, Angell's former Michigan teacher. John Dewey was now head of the Department of Philosophy at the University of Chicago. Angell was offered an assistant professorship there, with the opportunity of taking charge of the laboratory and the courses in psychology. Thus, in 1895 he began his career as psychologist at Chicago, which terminated in the academic year 1918–1919, when he was acting president of that university.

Angell's scientific writings, aside from his unpublished doctoral dissertation, first took the form of critical reviews of scientific literature on memory, thought and imagery, habit and attention. Shortly after his Chicago laboratory was going, however, there began a series of joint publications with his students on experimental studies. These included contributions to such topics as the influence of attention and habit on reaction time, the organic effects of agreeable and disagreeable stimuli, the relations of dermal and optical space, monaural localization of sound, and the relation of organic processes to consciousness (for a bibliography to 1931 see reference 5). Rooted in laboratory research results and nurtured by discussions with Dewey and others, there gradually grew up in Angell's mind a newly organized scientific outlook for psychology, which came to be known as "functional psychology," in contrast to the "structural" point of view. Angell championed the position that psychology is the science of mental operations rather than the science of mental elements. This position, sometimes designated as the "functional school" (4), was clearly foreshadowed in his psychology textbook of 1904, which had the supplementary title, "An Introductory Study of the Structure and Functions of Human Consciousness." His text was very successful and reached a fourth edition in 1908. In his presidential address before the American Psychological Association in 1906 on "The Province of Functional Psychology" he gave this point of view its clearest statement and strongest impetus. The functional formulation was strengthened through interest at the time in the development of educational psychology, experimentation on animals, and the study of intelligence through mental tests.

Angell's efforts to mold psychology into something more respectable and presentable among the sciences, as well as more representative of the range of man's psychological life, were no doubt in part stimulated by his very close association with leading scientists in other fields. Albert Michelson was his warm friend and tennis companion, Jacques Loeb and Henry Donaldson were next-door neighbors. Robert Millikan, Henry Gale, Eliakim Moore, Julius Stieglitz, and George Hale, to mention some who represented the exact sciences, were among his close friends and constant associates. Even Angell's ready and brilliant wit could not wholly satisfy such associations; his science had to be good. It had to be founded on something solid, its experimental and quantitative data demanded integration around an acceptable and practical philosophic viewpoint. Angell was not lack-

ing under this stimulation. He played everything he had and hit the psychological jack pot; many excellent students were attracted to his laboratory, and through them and their successful careers his influence was multiplied.[1]

Throughout the period of his deanships at the University of Chicago, 1908–1919, Angell continued to direct the psychological laboratory and to be productive in psychological writing and editing. He brought out his second volume, *Chapters from modern psychology,* in 1912, remodeled his introductory text in 1913, and again in 1918. He published a considerable number of articles, and contributed chapters. In connection with the American Psychological Association Angell was a leader in standardizing experimental procedures and mental tests and in organizing laboratory courses and apparatus for psychology. He thus played a prominent role both in systematizing the objectives and content of the young science of psychology, and also in organizing its teaching as a laboratory science and promoting its applications in the broad field of American education.

In World War I, Dean Angell participated on a full-time basis with other psychologists in devising and adapting psychological methods to the large task of classification of personnel in the Army. Later he was an advisory member on the Committee on Education and Special Training. At the end of the war he became full-time chairman of the newly organized National Research Council, which he served during the year 1919–1920. The Council, created as an operating agency under the National Academy of Sciences by President Woodrow Wilson, largely took form under the direction of Angell's associate and friend, George E. Hale. For a few months prior to Angell's chairmanship, John C. Merriam, later to become president of the Carnegie Institution of Washington, had served in this capacity.

The quality of Jim Angell's mind, his ability to immerse himself in a large amorphous subject, to sort out its logical relations, to see practical implications, and to present the subject in challenging description and orientation for his fellows is illustrated in his leadership of the National Research Council. Shortly after becoming chairman, he addressed the Twenty-First Annual Conference of the Association of American Universities on the subject, "The Organization of Research" (*1*). In this address, which is one of the most comprehensive and lucid statements of the platform of science, and as applicable now as then, he analyzed the concept of research, and the distribution of research functions. He discussed personnel, training of research men, organization, and cooperation in research, and presented the possibilities opened up through the creation of the National Research Council. Concerning the fundamental nature of research, Angell said: "I would accordingly urge that in our conception of research we look beyond the peculiar combination of intellectual traits, which may characterize any one individual, and think of it as the organized technique of science itself for its own propagation. It is, so to speak, the reproductive process of science. When thus conceived it takes on a far larger and more momentous aspect than when thought of, as too often at present, as being a mere appendix to the processes of science, a sort of luxury of the scientific idle rich."

While Angell was chairman of the National Research Council (1920) he was elected to the National Academy of Sciences. He was the sixth psychologist to be elected to the Academy.[2] His maternal grandfather, Alexis Caswell, mathematician and astronomer and sometime president of Brown University, was one of the fifty charter members. Also during 1920 the Carnegie Corporation made a large gift for the support of the National Academy and the Council and for the erection of a stately building on Constitution Avenue in Washington. In association with Robert Millikan and George Hale, Angell was successful in securing from private sources the considerable fund required to purchase the site where the building now stands. These activities brought him into close touch with Elihu Root and the Board of Trustees of the Carnegie Corporation. Mr. Carnegie had died in 1919, and before and following his death the affairs of the corporation had been under the guidance of a small board of trustees with Mr. Root as chairman. The board now invited Mr. Angell to become president of the corporation. This unprecedented offer, if yielded to, meant severing his connection with university work, and dismissing the attractive and strong probability of his succeeding President Judson at the University of Chicago. It was a difficult decision, but he accepted this newly created and broad executive position—to which, needless to say, he brought large competence and vision.

[1] In his autobiography (page 38) Angell mentions the following among his women students: Helen Thompson Woolley, June Downey, Florence Richardson Robinson, Kate Gordon, Jessie Allen Charters, Ada Hart Arlitt, Grace and Mabel Fernald, Mary Hayes, Stella B. Vincent, Helen Koch, Jean Weidensall, Dagny Sunne, and Edwina Abbott Cowan. Among his men students he lists: John B. Watson, Joseph Harvey, and John Peterson, Walter Hunter, Harvey Carr, Beardsley Ruml, Clarence Yoakum, Curt Rosenow, L. L. Thurstone, Joseph Hayes, Myron L. Ashley, Walter V. Bingham, Henry F. Adams, Edward S. Robinson, Harry D. Kitson, Carl Rahn, Conrad L. Kjerstad, Jacob R. Kantor, Louie W. Webb, F. A. C. Perrin, Joseph U. Yarborough, Elmer K. Culler, and Rutledge T. Wiltbank.

[2] Those whose election preceded that of Angell were: James McKeen Cattell (1901), William James (1903), Josiah Royce (1906), John Dewey (1910), and G. Stanley Hall (1915).

These two years in Angell's life—the first as chairman of the National Research Council and the second as president of the Carnegie Corporation—proved to be important for the future of Yale University. They were supertraining and broadening years, which against Mr. Angell's solid scientific and educational background, at the age of 52, prepared him obviously and exceptionally to succeed Arthur Hadley as president of Yale in 1921. Not for a century and a half had Yale chosen a leader outside the frame of its own traditions. In prospect, the "bulwark of tradition" must have looked somewhat ominous, but Mr. Angell won hands down. As an adopted son, or perhaps it was naturalized stepfather, he was readily accepted by students, faculty, and alumni. His sixteen years as president of Yale were effective and brilliant, and constitute a great period in the history of that institution. In his administrative office he had the loyal, devoted, and skillful support of George Day, Thomas Farnam, Robert Hutchins, Carl Lohmann, Wilbur Cross, and Charles Seymour, as top team. The combination was good. Developments too numerous to mention took place; the educational climate of the country was ready for them and was improved by them. Mr. Angell was successful in convincing the Yale alumni that the university's acceptance of the munificent gift of Edward S. Harkness for the establishment of the residential college system constituted a great step forward. The adoption of "the College Plan" will always be remembered as one of the notable achievements of his administration. It was on February 22, 1930 that Mr. Angell announced the adoption of the residential college system at Yale and the appointment of the first master in the person of Robert D. French. Another accomplishment which should also never be forgotten was the success of the movement, initiated at Angell's urging, for the enlargement of the university's endowment. Carried forward under his enthusiastic leadership, the campaign resulted in obtaining the then incredibly large sum of twenty million dollars for the making "of a finer, not a bigger Yale." To this project over 22,000 of Yale's friends pledged support in one year.

In 1937 no one was concerned that Mr. Angell at retirement would be lacking employment. What overtures or offers he received are not publicly known. But that he became educational counselor for the National Broadcasting Company is no secret. What he did in this new educational position as a kind of presiding judge over the content broadcast by radio waves around the globe, and what influence this may have had on man and his destiny only The Almighty knows. That his counsel was sought and valued and acted upon in an ultramodern institution staffed by brilliant, imaginative young men, who chose and accepted him as a colleague in their great exploratory enterprise, must have given him deep satisfaction.

The term "emeritus" never fitted well in Angell's case, except perhaps on the page of a college catalog. From the age of 45 or 50 to the very end of his gallant life, in New Haven on March 4, 1949, he was in constant demand to serve on committees, commissions, and boards of directors, and as a speaker on all sorts of select occasions. He could shift the mood of an audience as easily and as nonchalantly as he changed his spectacles but he never let them leave without some new and important mental imprint. Numerous published addresses reveal President Angell's qualities of mind and something of his charming personality, but unfortunately they seldom include many of the humorous asides that so characteristically accompanied his associations and appearances. Scores of these are treasured memories, as for example, when after walking in the rain in the procession at the Harvard Tercentenary, he said: "This is one of the ways in which Harvard soaks the rich." His type and his order of achievement appear rarely in any generation. Science and education in its forward progress will look back to him with admiration and affection.

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Smear Preparations for the Electron Microscopy of Animal Chromosomes[1]

Jack Schultz and Robert C. MacDuffee[2]

Lankenau Hospital Research Institute and
The Institute for Cancer Research, Philadelphia

Thomas F. Anderson

Eldridge Reeves Johnson Foundation for Medical Physics,
University of Pennsylvania, Philadelphia

AN ESSENTIAL REQUIREMENT for an electron microscope preparation is that it pass the test of light microscopy: its structure should appear at least as well preserved as the best conventional preparations for cytological study. The most useful procedure for the analysis of chromosome structure in the light microscope has been the so-called squash or smear technique. The squashing or smearing of cells between slide and cover slip is used to break the nucleus, thus setting the chromosomes free for study, and furnishing specimens with regions that are stretched so thin that details of the internal structure can be looked for. Until the present work, no successful routine had been developed by which the smear technique could be adapted to furnish electron microscope preparations.

Methods previously employed for the electron microscope study of chromosomes include isolation of the individual chromosomes by microdissection (*1, 3–5*); the preparation and isolation of chromatin threads by differential centrifugation of disrupted nuclei (*6*); and the cutting of very thin sections of embedded tissue (*4, 8*).

The procedure to be described here is an adaptation of the standard cytological smear technique, and provides preparations suitable for study in both light and electron microscopes.

1. *Primary fixation and squash.* The first step in the procedure is carried out as for conventional light microscopy. In making good squash preparations one must fix the material rapidly enough to preserve structure, without hardening it so much that it cannot be stretched. A fixative-stain containing 2 percent orcein and 60 percent acetic acid is satisfactory for both types of cell studied here, *Drosophila* salivary gland cells and the spermatocytes of man. The material can be dissected either in the appropriate Ringer's solution, or in the fixative-stain. In either case, dissection should be followed by about ten minutes in the fixative-stain, to a fresh drop of which the material is then transferred. A clean cover slip is mounted over it, held at one side with a piece of blotting paper, and tapped with a needle under the dissecting microscope, first to spread the cells into a single layer, then more forcibly to break the nuclei. They are then compressed still further by rolling the thumb, with maximum force, over a fresh piece of blotting paper placed upon the cover slip to remove excess fluid from the preparation.

2. *Transfer to formvar film.* The preparation is frozen over a block of dry ice, after which the cover slip can be pried off with a chilled razor blade. Part of the material then adheres to the slide and part to the cover slip. On the desired part of the preparation is then placed a drop of 95 percent glycerine and 5 percent saturated aqueous solution of lanthanum acetate. The lanthanum acts as an additional fixative, important for preserving the structure through the later treatments, and possibly serves as an electron stain for the nucleic acids.

A slide or cover slip previously coated with a formvar film approximately 200 A thick is quickly placed over the cellular material. Inserted into the jaws of a vise, the preparation is pressed firmly against the film, but not so forcibly as to smash the chromosomes. The preparations are now examined under the light microscope, and failures are discarded.

Slide and cover slip together are now placed in a Coplin jar containing a third fixative, a solution of three parts saturated picric acid, and one part formalin (40 percent formaldehyde). After six to twelve hours in this solution, the slide and cover slip will have separated, leaving some of the chromosomes attached to the formvar film.

3. *Dehydration.* The preparation on the film is now rinsed in distilled water and carried through the usual series of increasing concentrations of alcohol,

[1] Aided by an institutional grant from the American Cancer Society to The Institute for Cancer Research, and by Contract N6-ori-168 Task Order II between the Navy Department and the Trustees of the University of Pennsylvania.

[2] Present address, Army Medical Department Research and Graduate School, Army Medical Center, Washington 12, D. C.

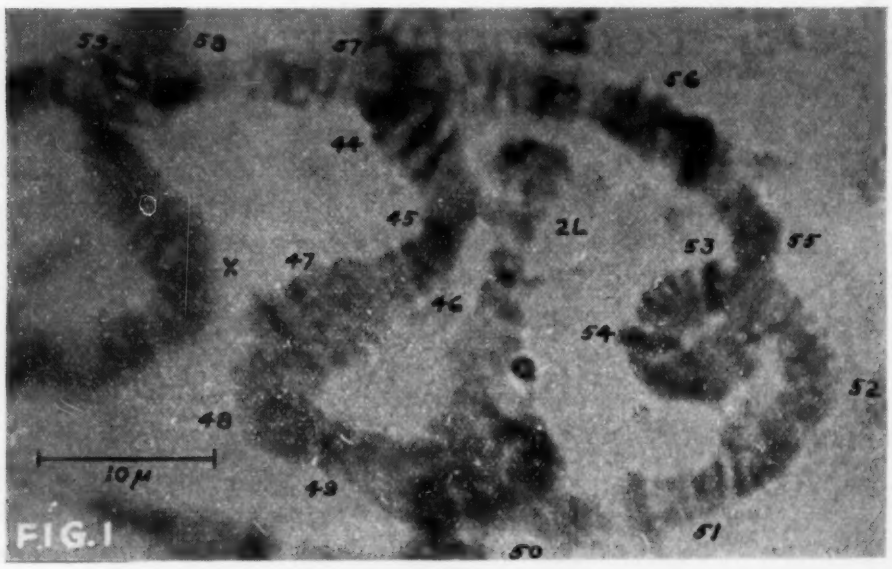

FIG. 1

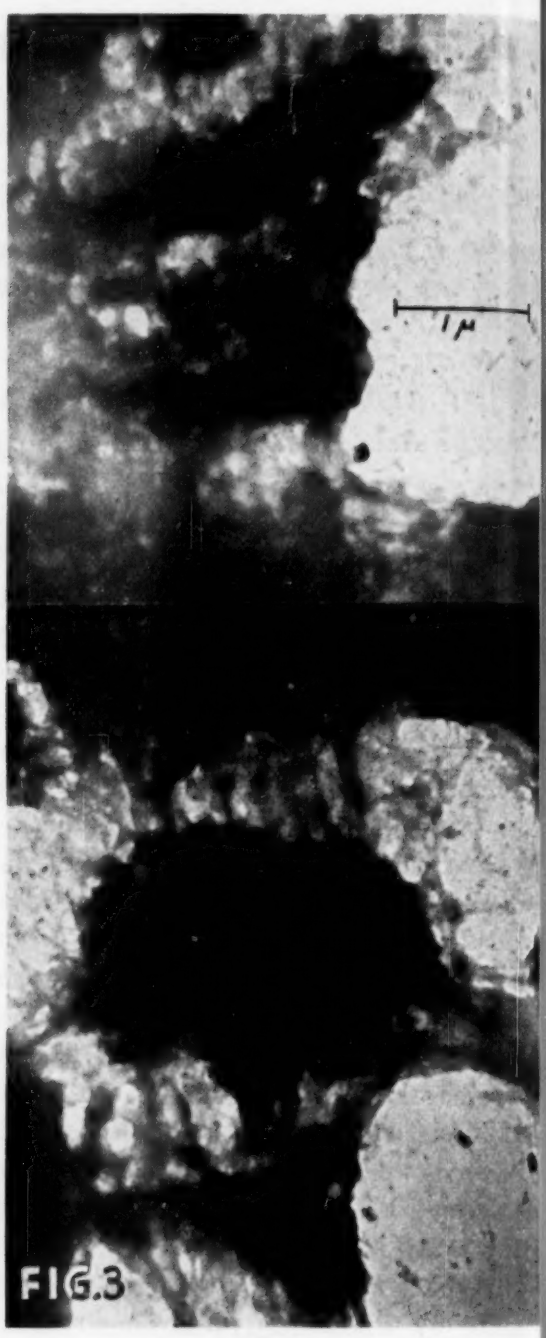

FIG. 3

FIG. 2

and finally through two changes of absolute alcohol. Following this, it is placed in a 0.5 percent solution of collodion in absolute alcohol for ten minutes. On removal, the preparation is allowed to dry in air and, being imbedded in collodion, suffers little or no distortion.

Extractable collodion is then removed with absolute alcohol, two changes of two hours each. The preparation can now be dried once more, without visible damage to the structure.

4. *Selection of region for study.* The preparation is ready for an exploratory examination under the high dry objective. The region found appropriate for study is cut around with a dissecting needle and teased up to permit a drop of water to flow under the plastic film (*9*), the drop being confined by a ring drawn with a wax pencil. The supporting grid for use in the electron microscope is then slipped under the film and the water is drawn off with a piece of blotting paper. A small amount of detergent in the water facilitates wetting the grid.

5. *Examination under oil immersion (light microscope).* The dried preparation, screen and all, may now be immersed in oil—cedar oil, for example—so that favorable regions can be studied and photographed under optimal conditions for light microscopy. By gentle washing in chloroform, the oil may be removed from the specimen, which is then ready for study in the electron microscope.

An example of the results obtained by our procedure is shown in Fig. 1. It is a light microscope photograph of part of a larval salivary gland nucleus of *Drosophila melanogaster*. Larvae from homozygous Oregon R stock were used, containing mutants *gt* and w^a. We have identified the chromosome regions according to the maps of Bridges (*2*). Sections 44 to 59 of chromosome 2R are outlined by the rectangle of the figure. Unidentified portions of chro

mosomes X and 2L can also be seen. In Fig. 2, a montage of a series of electron micrographs of this same section is shown. It is distorted somewhat by breaking of the formvar film. It is clear that the

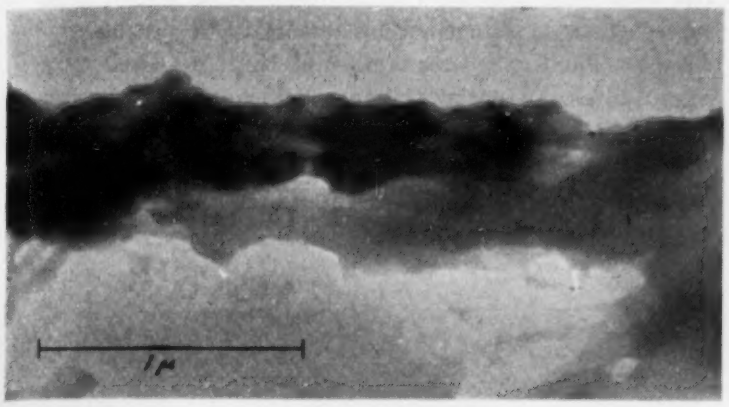

FIG. 4.

bands of the light microscope map, corresponding to the Feulgen-positive, ultraviolet-absorbing regions shown to be nucleoprotein in character, are also the regions of greatest density to the electron beam.

In Fig. 3, a higher magnification shows fine structures. The bands are seen to be composed of a multitude of particles like those seen in the thin sections of Pease and Baker (*8*), and in the replica preparations of Palay and Claude (*7*) demonstrated in a lecture at the University of Pennsylvania. Pease and Baker have made a somewhat detailed discussion of the fine structure of their preparations. Our results, so far as they go, are not in contradiction to theirs. However, it is too early to give support to their suggestion that the character of a band is determined by the size and shape of the individual particulate bodies of which it is composed.

The less dense interband regions show varying numbers of fibrils extending from one band to the next. On these fibrils small globules can be seen, sometimes regularly, sometimes irregularly spaced on adjacent fibrils. The irregularities are perhaps due to unequal stretching. If the globular particles represent types of bands, they would be below the limits of resolution of the light microscope. The fibrils that carry the globules have roughly the same diameter within one interband space. The larger fibrils may, however, be aggregates of smaller ones, some of which are just resolved. It would be premature to discuss the relation of these fibrils to theories of the structure of the giant chromosomes.

Fig. 4 shows an electron micrograph of a similarly prepared human pachytene chromosome, from the same type of material as that used in the study of the nucleolar chromosome of man by Schultz and St. Lawrence (*10*). Here also the alteration of density, corresponding to chromomere and interchromomeric regions, can be seen. The picture corresponds quite well to the studies in similar stages in *Lilium* (Elvers) and *Zea* (Buchholz). In the present micrographs it is possible to see a fine structure of fibrils in the interchromomeric regions (interbands).

The identification of genes with definite areas of the chromosomes of *Drosophila* was made possible as the result of a correlated study of the genetics and cytology of chromosome rearrangements. With the present technique, it is evident that the study can be extended to the electron microscope, and a basis laid for a discussion of the relation of the ultrastructure of the chromosomes to the genes. Similarly, as in human material, where chromomeres are at the limit of resolution of the light microscope, the use of the electron microscope is essential to further progress in mapping chromosomes.

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TECHNICAL PAPERS

Absorption of Radioactive Phosphorus by Mycorrhizal Roots of Pine[1]

Paul J. Kramer and Karl M. Wilbur[2]

Department of Botany, and Department of Zoology, Duke University, Durham

It has been demonstrated that under certain conditions, especially when growing in infertile soil, tree seedlings bearing mycorrhizal roots grow better than those which do not possess mycorrhizae. The improved growth apparently results from greater absorption of mineral nutrients. Routien and Dawson (*3*), for example, found that seedlings of *Pinus echinata* possessing mycorrhizae absorbed more calcium, magnesium, iron, and potassium than seedlings lacking mycorrhizae, and McComb and Griffith (*2*) found the same to be true of certain other species of conifers with respect to phosphorus. Hatch (*1*) attributed most of the beneficial effect of mycorrhizae to the increased absorbing surface, but others (*2*, *3*) believed the higher metabolic activity of mycorrhizal roots to be the cause of their greater intake of minerals.

Apparently no direct measurements of mineral absorption by mycorrhizal roots have been made, the conclusions concerning their high efficiency as absorbing structures being based on differences in growth and in chemical composition of plants possessing them as compared with plants lacking them. By immersing roots in radioactive phosphorus and preparing radioautographs it is possible to obtain direct evidence concerning the relative amounts of phosphorus absorbed by various root regions. This method was used to compare the amounts of phosphorus accumulated in mycorrhizal and nonmycorrhizal roots of pine seedlings. The species used were loblolly pine (*Pinus taeda* L.) and red pine (*P. resinosa* Ait.).

Pieces of root 10 to 15 cm in length obtained from potted pine seedlings were carefully washed in distilled water, and gently freed of bits of soil and other foreign matter with a camel's hair brush. P^{32}, essentially carrier-free, was obtained in acid solution and was diluted with distilled water to the desired activity which varied from 100–500 μc l in various experiments. The pH of the solution was adjusted to about 5.5 with NaOH. Roots were exposed for 3 or 4 hr to the radioactive solution in shallow dishes to insure adequate aeration. They were then rinsed in distilled water for 30 sec, in 0.001N H_3PO_4 for 10 sec, and again rinsed in distilled water for 30 sec. The acid rinse was used to aid in freeing the surfaces of the roots from adsorbed radioactive phosphorus by exchange. The washed roots were blotted and dried between glass plates. Medium lantern slides were then placed with emulsion side toward the roots, but separated from them by sheets of aluminum foil, 0.01 mm thick, for periods ranging from a few hours to 3 days, depending on the activity of the roots.

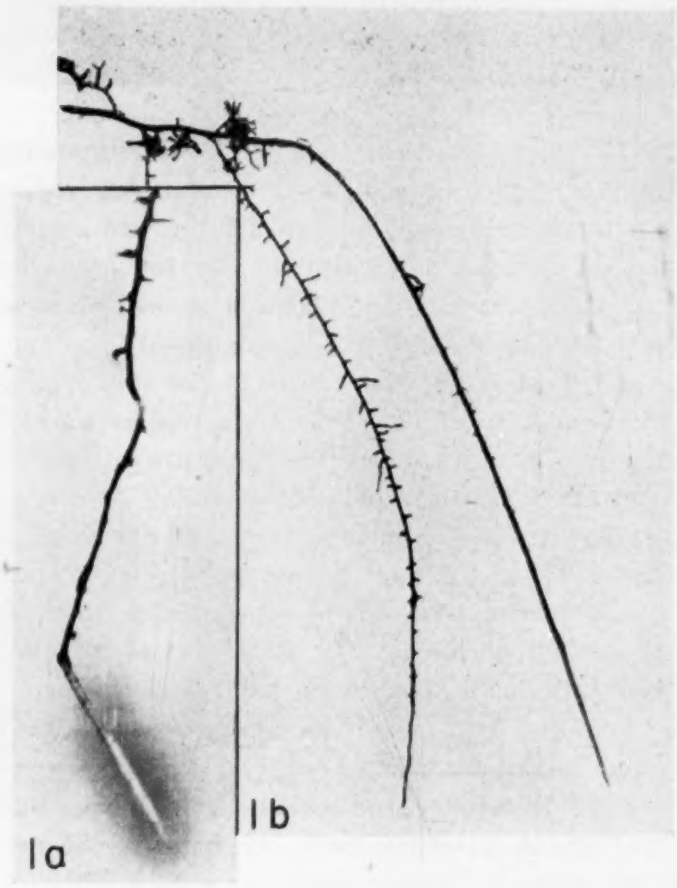

FIG. 1. Photographs (actual size) of portions of roots of red pine seedlings grown in soil, showing unsuberized (lower portion of each root) and suberized regions, mycorrhizal clusters (upper portion of 1b), and short branches. Many of the latter appear to be pseudomycorrhizal or nonmycorrhizal.

Photographs of typical roots of red pine are shown in Fig. 1, a and b, and their radioautographs in Fig. 2, a and b. These roots were cut into 1-cm segments and the activity of each segment was measured with a Geiger-Müller counter. The relative activity of each segment is indicated on the autographs.

As would be expected, there is less phosphorus accumulated in the completely suberized portions of the main roots than in the unsuberized region near the root tips. This is apparent in Fig. 2a and the left hand root of Fig. 2b. The right hand root in Fig. 2b is less mature and the numerous branches are scarcely visible. The coralloid clusters of mycorrhizal roots (upper portion of Fig. 2b) show the largest accumulation, supporting the common belief that they are actively involved in nutrient intake. Perhaps even more interesting is the

[1] This work was made possible by equipment supplied to Duke University through a contract with the Office of Naval Research (N7onr 45504).

[2] We wish to acknowledge the generous cooperation of Dr. N. S. Hall of North Carolina State College of Agriculture, Dr. Philip Handler of the School of Medicine, and Mr. Delmar Seevers of the Physics Department of Duke University, also the assistance of Miss Suzanne H. Berger.

relatively great accumulation of radioactive phosphorus by the short branch roots, even by those which show none of the hypertrophy or dichotomous branching characteristic of typical mycorrhizae. Some of these branch roots resemble those pictured by Hatch (*1*) in his Plate III, A, B, and F, and in Plate XIII, B, and described as nonmycorrhizal or pseudomycorrhizal roots. These he believed to be of negligible importance in the absorption of nutrients. Although these roots appeared to be suberized almost to their tips and therefore had a very limited absorbing surface we found that they accumulated surprisingly large amounts of phosphorus. Measurements of radioactivity indicated that the tips of the main roots

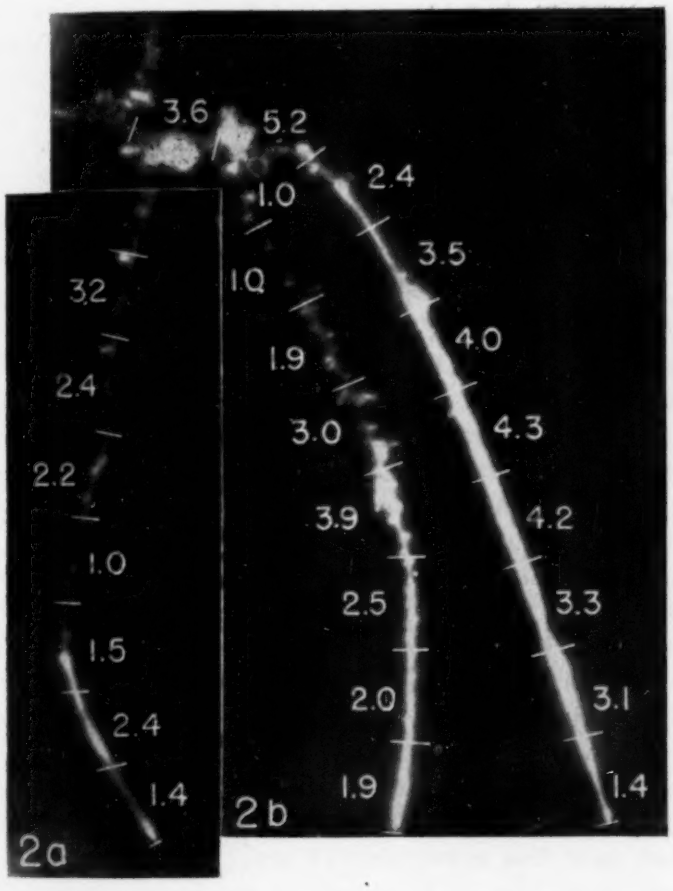

FIG. 2. Radioautographs of the roots pictured in Fig. 1. The numbers indicate relative radioactivity of 1-cm segments as measured by a Geiger counter.

did not contain as much radioactive phosphorus as the older portions bearing branches. A heavily suberized root bearing a few short branches or a small cluster of mycorrhizal roots apparently can absorb more phosphorus than an unbranched tip with a much larger unsuberized surface.

In a few instances autographs indicated that completely suberized roots absorbed considerable phosphorus, but microscopic examination of such roots showed that they were covered with a superficial layer of mycelium which apparently has a very large capacity to accumulate phosphorus. The few mycorrhizal branches which failed to show accumulation were dark and wrinkled, and apparently dead. A few unsuberized root tips showed very low accumulation of phosphorus, indicating that not all unsuberized root surfaces are equally active in absorption of solutes.

It appears possible that the increased accumulation of phosphorus by mycorrhizal roots may not result only from increased surface but perhaps may be related to a greater capacity for absorption because of high metabolic activity. Routien and Dawson found the oxygen consumption of mycorrhizal roots to be two to four times that of nonmycorrhizal roots. In preliminary experiments we have found that 10^{-3} M sodium azide, which may be expected to inhibit oxygen consumption, reduces the accumulation of P^{32} by both mycorrhizal and nonmycorrhizal roots. Study of the effect of respiration inhibitors was complicated by variations in proportion of mycorrhizal to nonmycorrhizal tissue in root samples, making quantitative comparisons difficult.

The results of these experiments show that mycorrhizal portions of roots of pine can accumulate much larger quantities of phosphorus than nonmycorrhizal portions. Root segments bearing short, unbranched, pseudomycorrhizal lateral roots appear to accumulate more phosphorus than typical unsuberized root tips. It seems possible that mycorrhizal roots have not only a greater surface, but also a greater capacity to accumulate phosphorus per unit of surface than nonmycorrhizal roots. Apparently in pine roots the region of maximum intake of minerals is not the root tips, as in roots of herbaceous plants, but the older regions where mycorrhizal or pseudomycorrhizal branch roots have developed.

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A Qualitative Analysis of the Amino Acids in Royal Jelly[1]

John J. Pratt, Jr.[2] and Howard L. House[3]

Department of Entomology, Cornell University, Ithaca

Royal jelly, a secretion of the pharyngeal glands of the young worker of the honey bee, *Apis mellifera* L. (*6*), is the sole food of bee larvae which develop into sexually mature female adults, or queens. Larvae which develop into sexually immature female adults, or workers, are fed royal jelly for 2 days, then receive a mixture of pollen and honey during the remainder of their 5-to-6-day feeding period (*9*). Research toward an explanation of the role of royal jelly in the development of castes of *Apis mellifera* L. has been reviewed by Haydak (*6*).

Chemical analyses of royal jelly have shown that it is a complex mixture of substances having a protein content of 9 to 18% of the fresh material (*6*). The proteins were found by Abbott and French (*1*) to consist of an

[1] Aided by a grant from the Lalor Foundation of Wilmington, Delaware.

[2] Present address: Bureau of Entomology and Plant Quarantine, Beltsville, Maryland.

[3] Present address: Dominion Parasite Laboratory, Belleville, Ontario, Canada.

albumin and probably a globulin in the ratio of 2 to 1. Aeppler (*2*) by unstated methods and Townsend and Lucas (*10*) by chemical methods identified 7 amino acids in the hydrolyzed proteins of royal jelly (Table 1), but did not investigate the possibility of the occurrence of free amino acids in this substance. During the course of research on free amino acids in the blood of insects, an analysis of both free and combined amino acids in royal jelly was undertaken. Separation and identification of amino compounds was accomplished by the paper chromatographic method of Consden, Gordon, and Martin (*5*).

Approximately 0.5 ml of fresh royal jelly was suspended in 1 ml of distilled water and diluted with 10 ml of 95% ethyl alcohol in order to precipitate the proteins.

TABLE 1

FREE AND COMBINED AMINO ACIDS OF ROYAL JELLY

Amino acid or derivative	As free compound	As protein constituent
Alanine	+	+
Arginine	+	+*
Aspartic acid	+	+*
Cystine	–	+*
Glutamic acid	+	+
Glycine	+	+
Histidine	–	–*
Hydroxyproline	–	–
Isoleucine and/or Leucine	+	+
Lysine	+	+*
Methionine	+	+
Phenylalanine	–	+
Proline	+	+
Serine	+	+
Threonine	–	+
Tyrosine	+	+*
Tryptophane	–	–*
Valine	+	+
β-Alanine	+	
Glutamine	+	
Taurine	+	
Unknown	+	

* Previously reported (*2*, *10*)

The precipitated proteins were separated by centrifugation, and the supernatant, which contained free amino acids, was drawn off. The proteins were washed with 1-ml aliquots of 95% alcohol until a negative ninhydrin reaction was obtained in the washings. The solution was evaporated to dryness by means of a jet of air and the residue dissolved in 300 μl of distilled water. Aliquots of 50, 100, and 150 μl were chromatographed.

The precipitated proteins were divided into two portions, one of which was hydrolyzed with 5 N NaOH and the other with 6 N H_2SO_4. Hydrolysis was accomplished by autoclaving for 12 hr at 15-lb pressure. The hydrolyzates were neutralized, then evaporated to 0.5 ml by means of an air jet and gentle heating. Aliquots of 50 and 100 μl were chromatographed.

It is evident from the data in Table 1 that significant quantities of amino acids and amino acid derivatives occur in the free state in royal jelly. The presence of cystine, histidine, hydroxyproline, phenylalanine, threonine, and tryptophane was not demonstrated. It is possible that extraction of amino acids from a larger sample of royal jelly would demonstrate the presence of histidine, for it is the least sensitive of the amino acids to identification by paper chromatography (*8*). Assuming complete extraction of free amino acids from the sample of royal jelly, an estimation based on the volume of aliquots chromatographed and on sensitivities of various amino acids to the method (*8*) indicates that, if amino acids not found in the free state do occur as such, they are present in less than the following quantities per ml of fresh royal jelly: cystine 0.032 mg, histidine 0.1 mg, hydroxyproline 0.004 mg, phenylalanine 0.02 mg, threonine 0.008 mg, tryptophane 0.008 mg.

Hydroxyproline, histidine, and tryptophane were not identified in hydrolyzed proteins of royal jelly. The latter two compounds were found in hydrolyzed proteins of royal jelly by Aeppler (*2*) and by Townsend and Lucas (*10*). Further research is needed to clarify this discrepancy.

The size and color intensities of proline spots occurring on chromatograms of free amino acids were greater than those occurring on protein chromatograms, indicating relatively large quantities of free proline in royal jelly. Auclair and Jamieson (*3*) have shown that pollen (dandelion, willow, and mixed taken from a beehive; and dandelion collected from blooms) is rich in free proline, which may explain its abundance in royal jelly since young worker bees consume pollen during their period of secretion of royal jelly.

The presence of free taurine in royal jelly is of interest. This compound, which is formed from cysteine in the animal body and is a constituent of the bile salts of animals, is known to occur in large quantities in muscle tissue of invertebrates, but its function there is unknown (*4*). Free taurine has also been found in blood of honey bee larvae and of two other adult insect species (*7*).

An amino compound of unknown composition was isolated as a free constituent of royal jelly. It has also been found free in the blood of honey bee larvae (*7*) and in pollen (*3*). Comparison of its chromatographic position with those of several known amino compounds has thus far failed to identify this interesting compound.

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The Effect of 7-Ketocholesterol on the Rabbit

R. H. Cox[1] and E. Y. Spencer

Department of Chemistry, University of Saskatchewan, Saskatoon, Canada

Wintersteiner and Bergstrom found that a stream of air passed through a colloidal solution of cholesterol resulted in the production of principally 7-ketocholesterol and 7-hydroxycholesterol (*10*). Kendall, Meyer, and Bevans (*6*) reported that single intravenous injections into rabbits of such oxidized solutions produced lipid droplets within the cells of the intima in 24 hr. Multiple intravenous injections led to an immediate increase of sudanophilic material in the intima, which roughly paralleled the amount of oxidized material injected. In control experiments of these workers, early changes did not result from the administration of unoxidized cholesterol. However, if high plasma cholesterol levels were maintained for several weeks by repeated injections of either unoxidized or oxidized material, there was little difference in the extent or character of the lesions produced.

7-Ketocholesterol was prepared by us according to the method of Windaus, Lettre, and Schenk (*9*). Altschul (*1*) found that when this compound was given to rabbits either orally (in capsules of 0.3 g daily) or percutaneously, as a solution in benzene and vegetable oil (approximately 0.1 g daily), it produced none of the cellular reactions characteristic of the administration of pure cholesterol. However, 7-ketocholesterol administered orally or percutaneously had a definite effect on the liver. Examination showed atrophy of the liver cords and the presence of necrotic areas, numerous giant cells, and an overgrowth of connective tissue and biliary epithelium. In two instances, this organ showed a characteristic "hobnail" surface.

Thus the pathological changes brought about with 7-ketocholesterol did not parallel those found by Kendall *et al.*, using colloidal solutions of cholesterol oxidized according to Wintersteiner and Bergstrom, and therefore presumed to contain chiefly 7-ketocholesterol and 7-hydroxycholesterol. This difference in pathological findings suggested that the effect of administering a mixture of α and β epimers of 7-hydroxycholesterol should be studied, and this is at present under investigation. Also of possible significance is the observation that, under optimum conditions for oxidation, these colloidal solutions contained about 20% unchanged cholesterol (*10*).

Collier and Cox have found that percutaneous administration of approximately 0.1 g of 7-ketocholesterol daily for 64 days resulted in a greatly increased sterol concentration (calculated as cholesterol) in the plasma, as detected by a modification of the Tshugaev reaction (*8*). However, examination of plasma from an animal which received orally 0.3 g of 7-ketocholesterol daily for 40 days showed a comparatively normal sterol level. The plasma of both animals contained only a trace of 7-ketocholesterol, when determined by the micromethod of these workers (*2*). The possibility that liver selectively reduces 7-ketocholesterol to cholesterol, or to a sterol giving a color reaction similar to that of cholesterol when determined by the zinc chloride-acetyl chloride reagent, is now being examined. Of interest in this investigation is the observation that the epimeric 7-hydroxycholesterols, which can be prepared by the selective reduction of the keto group in 7-ketocholesterol (*9*), have been isolated from ox liver in recent years (*3, 4, 7*). However, it is not known whether these hydroxycholesterols are true intermediates in sterol metabolism, or only autoxidation products of cholesterol, perhaps formed during the process of extraction (*5, 11*).

[1] Life Insurance Medical Research Student Fellow, 1948–49.

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Survey of Chinese Drugs for Presence of Antibacterial Substances[1]

H. Zanyin Gaw and H. P. Wang[2]

Biological Laboratory, National Wuhan University, Wuchang, Hupeh, China

In view of recent studies on the production of antibiotic substances by higher plants (*1–6*), it seems interesting to make a survey of drugs commonly used in the practice of Chinese medicine for the presence of antibacterial substances. The so-called Chinese drugs are actually roots, stems, seeds, leaves, or flowers of various higher plants in a very dehydrated state (prepared by special methods). This paper reports the results of such a survey.

To 10–20 g of a drug cut in small pieces, 150 ml of distilled water was added, and the mixture was then boiled slowly for 2–3 hr or longer to a final volume of about 25 ml. (This is the customary way of preparing Chinese medicine, except that ordinary tap water is used instead of distilled water.) After preliminary filtering, the filtrate, which is really a concentrated water extract

[1] This work was carried out in 1945 before departure of the authors for the United States. Since the return of the senior author to China in 1947, some of the experiments were repeated and extended.

[2] Present address: Department of Zoology, Mt. Holyoke College, South Hadley, Massachusetts.

TABLE 1

ANTIBACTERIAL ACTION OF CHINESE DRUGS*

Name of drug	Identified scientific name	*Staph. aureus*	*E. coli*
Ma Huang	*Ephedra sinica* Stapf. (stem)	0	0
Ma Tou Ling	*Aristolochia debilis* S. et Z. (fruit)	0	0
Si Sin	*Asarum sieboldii* Miq. (root)	0	0
Ta Huang	*Rheum palmatum* L. (or *R. officinale* Baillon) (root)	28–35	+
Peh Tou Ung	*Anemone chinensis* Bunge (root)	0	0
Mao Ken	*Ranunculus pensylvanicus* L. (leaf and fruit)	0	8–10
Huang Lien	*Coptis chinensis* Franch (stem and root)	17–20	0
Lien Chiao	*Forsythia suspensa* Vahl. (fruit)	0	0
Kou Teng	*Strychnos panicula* Champ. (stem)	0	0
Chang San	*Dichroa febrifuga* Lour. (root and leaf)	0	+
Hai Tung Pi	*Erythrina* sp. (bark)	18–24	0
Tu Chung	*Eucommis* sp. *ulmoides* Oliv. (bark)	0	0
Chai Hu	*Bupleurum falcatum* L. (root, stem, and leaf)	+	0
Ku Tsan	*Sophora flavescens* Ait. (var. Galegoides Hemsl.) (root)	0	0
Keh Ken	*Pueraria Thunbergiana* Benth. (root)	0	0
Tsao Chieh Chieh	*Gleditschia sinensis* Lam. (stem)	0	+
Huang Peh	*Phellodendron chinense* Schneid. (bark)	0	+
Ku Lien Tzu	*Melia Azedarach* L. (fruit)	+	0
Yuan Chih	*Polygala sibirica* L. (root and leaf)	0	+
Ta Chih	*Euphorbia pekinensis* Rupr. (root)	0	0
Pa Tou	*Croton Tiglium* L. (seed)	0	0
Ta Fung Tzu	?	0	0
Shih Chun Tzu	*Quisqualis indica* L. (fruit)	0	0
Peh Chih	*Angelica sp.* (root)	0	0
Fang Fung	*Siler divaricatum* B. et H. (root)	0	0
She Chuang Tzu	*Selinum Monnieri* L. (seed)	0	0
Shan Shu Yu	*Cornus officinalis* S. et Z. (fruit)	18–24	0
Shih Nan	*Rhododendron indicum* Sweet (leaf)	+	0
Chai Tsao	*Lithospermum officinale* L. (root)	0	0
Poh Ho	*Mentha arvensis* L. (stem and leaf)	0	0
Ti Kuh Pi	*Lycium chinense* Mill. (bark and root)	0	0
Ti Huang	*Rehmannia glutinosa* Libosch (root)	0	0
Chu Tsien	*Plantago major* L. (stem and leaf)	0	0
Tsien Tsao	*Rubia cordifolia* L. (root)	10–14	0
Jen Tung Teng	*Lonicera japonica* Thunb. (vine)	0	0
Chieh Keng	*Platycodon grandiflorum* DC. (root)	0	0
Tsang Muh	*Atractylis ovata* Thunb. (root)	+	+
Kuan Tung	*Tussilago Farfara* L. (flower)	0	0
Pu Kung Ing	*Taraxacum mongolicum* Hand.-Mazz (leaf, stem, and root)	0	0
Niu Pang	*Arctium Lappa* L. (seed)	0	0
Chi Hsueh Teng	*Tripterygium Wilfordii* Hook. f. (vine)	12–16	0
Cheh Sish	*Alisma plantago* L. (root)	0	0
Pan Hsia	*Pinellia ternata* Breit. (root)	0	0
Peh Pu	*Stemona sessilifolia* Miq. (or *S. japonica* Miq.) (root)	0	10–12
Chih Mou	*Anemarrhena asphodeloides* Bunge (root)	+	0

* 0 = no activity + = very slight inhibition
Numerals indicate size of inhibition zone in mm

of the drug, was made bacteria-free by passing through a Mandler diatomaceous filter candle at 8-lb pressure, and then was tested against *Staphylococcus aureus* and *Escherichia coli.* (Both cultures were supplied by the Department of Bacteriology, School of Medicine, National Central University.) No attempt was made to make any of the assays quantitative. The test plates were prepared as follows: bacterial cultures were grown for 24 hr in nutrient broth and 1-ml portions of these suspensions were plated in 1.5% nutrient agar. Porcelain Peni-cylinders were affixed to the surface of these plates immediately after hardening of the agar and filled with the drug extract to be tested. The plates were incubated at 37° C for 18–24 hr. The diameters of the inhibition zones were measured and recorded in mm. Results of the test are given in the table.

From Table 1 it can be seen that six of the drugs, namely: Ta Huang (*Rheum palmatum* L. or *R. officinale* Baillon), Huang Lien (*Coptis chinensis* Franch), Hai Tung Pi (*Erythrina* sp.), Shan Shu Yu (*Cornus officinalis* S. et Z.), Tsien Tsao (*Rubia cordifolia* L. and Chi Hsueh Teng (*Tripterygium Wilfordii* Hook. f.) showed various degrees of antibacterial activity for *Staphylococcus aureus,* while two others; Mao Ken (*Ranunculus pensylvanicus* L.) and Peh Pu (*Stemona scssilifolia* Miq. or *S. japonica* Miq.) showed antibacterial activity (of relatively low potency) for *Escherichia coli.*

The eight drugs that showed bacterial inhibition were tested for their effect on the respiration of the respective bacteria and their toxicity to animal tissues. The effect on respiration was measured by using the Warburg type of microrespirometer and it was found that none of the drugs has any effect on bacterial respirations although bacterial multiplication was checked, indicating that the drugs are bacteriostatic in action. The toxicity was tested on living human leucocytes, following the general procedures used by the Oxford workers (*6*). The leucocytes continued to move for about 2–4 hr after the drug extracts were added. They are, therefore, nontoxic which is to be expected, as prepared medicine is always administered orally in the practice of Chinese medicine.

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The Harefoot Mushroom, *Coprinus lagopus* Fr., on Fruits Used Commercially as Seedstocks[1]

W. F. Crosier, S. R. Patrick, C. E. Heit, and Elizabeth McSwain

Division of Seed Investigations, Cornell University, Geneva, New York, and
Seed Laboratory, College of Agricultural and Mechanical Arts, State College, New Mexico

Sporophores of the black-spored mushroom, *Coprinus lagopus* Fr., have developed saprophytically from fruits of several plants during germination testing of the enclosed seeds. They have been observed frequently on fruits of European-grown New Zealand spinach since 1940 and occasionally on seedballs (botanical fruits) of garden beets. The pileus of a sporophore was small in proportion to the stipe, 4 to 28 mm across, tender, at first cylindrical, covered with fugacious fibrils, at maturity becoming campanulate, then flattened, smooth, with edges revolute or split. A mature, fully elongated stipe was typically long, slender, hollow, fragile, and bulbous, 5 to 26 cm high, 2 to 7 mm in diameter, white and wooly. The gills were white when young, then black, free, remote, linear, and very thin. The spores were black, elliptical, easily visible through the thin flesh of the pileus, and averaged 11.7 to 13.1 × 6.3 to 7.4 μ.

The sporophores occurred singly, scattered, or in crowded clumps, of 20 to 30 on a fruit, seedball, or other nonliving structure enclosing the true seeds. The first sporophores of *Coprinus lagopus* usually matured in about 24 days after the infested fruits had been placed in a germinator operated at an alternating temperature of 20° and 30° C. During ripening, the stipes of the mushroom elongated rapidly, the pilei became flattened, and the gills deliquesced completely within a few hours. When removed from a humid germinator to the more arid laboratory, young sporophores arising from any medium invariably withered and failed to mature.

As previously suggested (*5*), the mushroom was recognized as *Coprinus lagopus* Fr. According to Saccardo (*7*), the spore sizes of this species are 12 to 13 × 6 to 8 μ, while the pileus is tender, 2 to 3 cm long, and the stipe is fragile. Rea's (*6*) description of *C. lagopus* is applicable, except in spore measurements of 10 to 12 × 6 to 7 μ, to the specimens observed at Geneva. Kaufman (*3*), in classifying 30 species of *Coprinus* of Michigan, included no specific description of *C. lagopus* but did state that *C. tomentosus* Fr. may be the *C. lagopus* of various authors. The mushrooms observed on fruits at Geneva, and at State College, New Mexico clearly did not conform to Kaufman's (*3*) description of *C. tomentosus,* although the spore sizes were parallel.

Previously Rea (*6*) and Pape (*4*) have identified agarics found on seedballs of beets and mangels as *Coprinus pilosus* Beck. and *C. nycthemerus* Fr. respectively. A few specimens growing on fruits of New Zealand spinach and seedballs of beets at Geneva might have been recognized as one of these species had not continued culturing produced the typically long-stemmed fruit bodies of *C. lagopus.* It is probable that both Rea and Pape would have assigned the beet-infesting mushroom to *C. lagopus* had they transferred their cultures to richer media.

Successful transferring of both the beet and New Zealand spinach strains to manure, rotten wood, and straw has shown that the size of the sporophore is somewhat dependent upon the medium. The transfers also furnished proof that the strains isolated at Geneva readily grow on the same media, manure and rotten wood, mentioned by Rea (*6*) and Pape (*4*) for English and German strains.

Since the first observation of *Coprinus lagopus* upon European-grown fruits of New Zealand spinach, the mushroom has fruited on garden beet seedballs, on the berry-like fruits or arils of yew (*Taxus cuspidata capitata* Sieb & Zacc.), on the calyx and bracts surrounding seeds of pincushion flower (*Scabiosa caucasica* Bieb.), and on glumes enclosing caryopses of bluestem wheatgrass (*Agropyron smithii* Rydb.), and of crested wheatgrass (*A. cristatum* Gaertn.). The sporophores of a *Coprinus* were previously (*1*) reported from the fruit or lomentum of sainfoin, *Onobrychis viciaefolia* Scop.

Fruit bodies of the larger species of *Coprinus* commonly collected for food have never developed from any commercial seedstock tested at Geneva. Attempts to establish these species in fruits of New Zealand spinach and in seedballs of garden beets have been entirely unsuccessful.

Apparently the mycelium of *Coprinus lagopus* was borne within the fruits, seedballs, glumes, or similar plant parts. Fungus hyphae have been demonstrated in those tissues from which sporophores developed. Furthermore, surface sterilization of New Zealand spinach fruits and of beet seedballs did not inhibit development of the sporophores of *C. lagopus.* The hyphae have not been demonstrated in the botanical seeds enclosed in fungus-infested fruits, and sporophores have never arisen from the seeds of any species.

Spores of *Coprinus lagopus* have not been found on seeds, fruits, or other plant structures received for routine germination testing. In fact, no evidence has been found to indicate that spores do, or even could, perpetuate the fungus.

The medium, whether a seed-enclosing structure or disorganized tissue, visibly affects the size of the fruit bodies. The stipes arising from glumes enclosing seeds of *Agropyron* spp. both at State College, New Mexico, and at Geneva were only 2 to 5 cm high, with pilei of 7 to 12 mm diameter. With successive transfers to blotting paper, New Zealand spinach fruits, and beet seedballs, the fruit bodies progressively increased in size. The larger stipes from the latter medium averaged 14 cm in length while the ripened pilei averaged 26 mm in diameter.

The size of the sporophore had only slight influence or none upon the size of the spores. The averages of 12 to 13 μ × 6 to 8 μ as specified by Saccardo (*7*) were

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applicable to spores dropping from 95% of the sporophores. The kind and size of fruit or similar plant part, while affecting the size of the sporophores, did not exert a similar influence upon the spores. The size of the spores remained very constant when a strain of *Coprinus lagopus* from *Agropyron smithii* was successively cultured on glumes of *A. cristatum*, seedballs of beets, and fruits of New Zealand spinach.

The size of the sporophores, the constancy of spore measurements, the ease of transfer of the fungus from fruits of one plant species to those of others, and the failure of the large edible species to grow upon fruits indicate that the harefoot mushroom is the species of *Coprinus* that has been observed at Geneva, New York, and at State College, New Mexico.

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The Validity of the Use of Tracers to Follow Chemical Reactions

Jacob Bigeleisen

Brookhaven National Laboratory, Upton, New York

In the use of tracers, either stable or radioactive, it is important to know how much difference in chemical properties there is between the isotopic molecules. The thermodynamic properties of systems containing isotopic molecules in chemical equilibrium can be calculated by simple formulae (*1*).

Recently Urey (*4*) tabulated the equilibrium constants of various exchange reactions for isotopic compounds of elements in the first row of the periodic table, as well as the halogens. In many cases the isotopic molecules are not in equilibrium with respect to various exchange reactions. In such cases it is important to know whether or not the specific activity of the product of some chemical transformation of the substrate isotopic molecules is the same as the initial specific activity. If the initial specific activity is known, then the specific activity of the product can be calculated by integration of the rate equations for the respective reactions. In this paper we shall neglect changes in the specific activity by radioactive decay or other nuclear processes. These corrections can be made by the use of the equations of radioactive transformation (*3*).

We shall consider the general case where the isotopic molecules A_1 and A_2 react either with each other or with other molecular species B, C, etc. to give the isotopic molecules X_1 and X_2 amongst the products. Frequently the isotopic molecule A_2 may be a mixed molecule and contain two different isotopes of one element in chemically equivalent positions, e.g., CH_3D. A mixed molecule may react in one of two ways. It may give the products X_2, Y, etc. or X_3, Y_2, etc. In most cases X_3 will be the same as X_1 but we shall retain the symbol X_3 to avoid confusion. If the isotopic molecule A_2 is present only in tracer amounts, then the reaction will always be first order in A_2. If a_1^0 and a_2^0 are the initial concentrations of A_1 and A_2 respectively, then the amounts of X_1, X_2 and X_3, dx_1, dx_2 and dx_3 respectively, formed in a time interval dt at the time t by reaction according to the following equations

$$A_1 + B + C + \ldots \xrightarrow{k_1} X_1 + Y_1 + \ldots \quad (1)$$

$$A_2 + B + C + \ldots \xrightarrow{k_2} X_2 + Y_1 + \ldots \quad (2)$$

$$A_2 + B + C + \ldots \xrightarrow{k_3} X_3 + Y_2 + \ldots \quad (3)$$

are

$$dX_1 = k_1(a_1^0 - lX_1)^n(B)^b(C)^c \ldots dt \quad (4)$$

$$dX_2 = k_2(a_2)(a_1^0 - lX_1)^{n-1}(B)^b(C)^c \ldots dt \quad (5)$$

$$dX_3 = k_3(a_2)(a_1^0 - lX_1)^{n-1}(B)^b(C)^c \ldots dt \quad (6)$$

where $$a_2 = a_2^0 - mX_2 - nX_3.$$

The coefficients l, m, and n are small numbers which are derived from the stoichiometry of the reaction.

From equations (5) and (6) it follows that

$$dX_3 = (k_3/k_2)\,dX_2 \quad (7)$$

and

$$X_3 = (k_3/k_2)X_2 \quad (8)$$

Thus

$$a_2 = a_2^0 - (m + nk_3/k_2)X_2 \quad (9)$$

From equations (4), (5), and (9) we get

$$\frac{k_2}{k_1}\int_0^{x_1}\frac{dX_1}{(a_1^0 - lX_1)} = \int_0^{x_2}\frac{dX_2}{a_2^0 - (m + nk_3/k_2)X_2} \quad (10)$$

Integration of equation (10) gives

$$\frac{X_2}{a_2^0} = \frac{1 - (1 - lX_1/a_1^0)^{k_2(m+nk_3/k_2)/k_1 l}}{m + nk_3/k_2} \quad (11)$$

If we define the specific activity of the product as $N_X = X_2/X_1$ and the initial specific activity as $N_{A^0} = a_2^0/a_1^0$, then

$$\frac{N_X}{N_{A^0}} = \frac{1 - (1 - lX_1/a_1^0)^{k_2(m+nk_3/k_2)/k_1 l}}{(m + nk_3/k_2)X_1/a_1^0} \quad (12)$$

For small amounts of conversion, $lX_1/a_1 << 1$,

$$\frac{N_X}{N_{A^0}} = k_2/k_1 \quad (13)$$

At complete conversion, $X_1 = a_1/l$,

$$\frac{N_X}{N_{A^0}} = \frac{l}{m + nk_3/k_2} \quad (14)$$

In a forthcoming publication from this laboratory (*2*) a general equation is derived for the ratio of the rate constants for reactions involving isotopic molecules. For reactions which occur at room temperature and above, the ratio of the rate constants can be expressed approximately by the equation

$$\frac{k_1 s_1 \ddagger s_2}{k_2 s_2 \ddagger s_1} = \left(\frac{m_2^*}{m_1^*}\right)^{1/2}\left(1 + \sum_i^{3n-6} G(u_i)\Delta u_i - \sum_i^{3n^1-6} G(u_i\ddagger)\Delta u_i\ddagger\right) \quad (15)$$

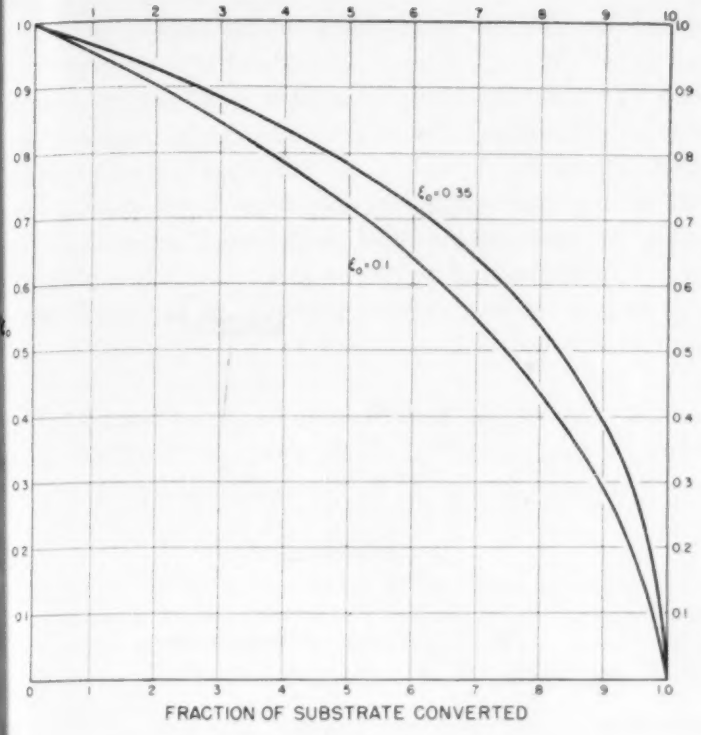

FIG. 1. Isotope effect in a chemical reaction involving isotopic molecules reacting with nonidentical rate constants vs. amount of reaction.

where the subscripts 1 and 2 refer to the light and heavy isotopic molecules respectively. A similar equation holds for the ratio k_3/k_2. The righthand side of equation (15) gives the amount that a simple statistical consideration must be corrected by. The symbol ‡ refers to a property of the activated complex in the reaction. The quantity s is the symmetry number; m^* is the effective mass of the activated complex along the reaction coordinate; $G(u)$ is a function of the normal vibrations of the molecule (*1*); $\Delta u_i = \frac{hc}{kT}(\omega_{i_1} - \omega_{i_2})$ where ω_i is a normal frequency of the molecule.

It is important to see how the specific activity of the product, N_X, compares with the initial specific activity, N_{i_0}, as a function of the amount of reaction. We shall consider the special case, which is one of wide generality, where $k_3 = 0$, and l, m, and the ratio $s_1‡s_2/s_2‡s_1$, are each unity. We shall now define ε and ε_0 by the relations

$$\frac{N_X}{N_{i_0}} = 1 - \varepsilon \tag{16}$$

$$\frac{k_2}{k_1} = 1 - \varepsilon_0 \tag{17}$$

In Fig. 1 curves are drawn for $\varepsilon/\varepsilon_0$ as a function of the amount of reaction for two values of ε_0. It is clear that for complete conversion of the substrate, $X_1/a_1 = 1$, $\varepsilon = 0$. This holds independently of the value of ε_0. For $\varepsilon_0 = 0.35$ the specific activity of the product is 4% different from the initial specific activity, even at 99% conversion.

We shall show presently that apart from the isotopes of hydrogen, the values of ε_0 are *usually* so small that there is little error made by assuming that it is zero. By comparison of equations (15) and (17) it is seen that ε_0 is equal to the deviation of the reciprocal of the righthand side of equation (15) from unity. The function $G(u_i)$ as well as Δu_i is always positive (*1*). $G(u_i) = \frac{1}{2} - \frac{1}{u_i} + \frac{1}{e^{u_i} - 1}$ and its value will fall between 0 and 1/2. Thus the maximum value of the ratio $k_1 s_1‡s_2/k_2 s_2‡s_1$ will occur when $\Sigma_1\, G(u_i‡)\, \Delta u_i‡$ is equal to zero. This corresponds to the physical situation where the isotopic atoms are essentially free, unbound chemically, in their respective activated complexes. The values of $\Sigma_i\, G(u_i)\, \Delta u_i$ for a considerable number of isotopic molecules of the light elements have been tabulated (*4*). It is not difficult to calculate additional values for other elements. Thus we can arrive at estimates for upper limits of the ratio of the rate constants for reactions involving many of the common tracers. These are tabulated in Table 1.

It is clear that the maximum isotope effects in the rates of reaction decrease rapidly as one goes to isotopic compounds of higher atomic number. Of the common tracers, H^2, H^3, C^{13}, and C^{14}, may require special consideration in their use in nonequilibrium systems. There are very few reactions of carbon compounds in which the activated complex contains even loosely bound carbon atoms. In fact, $\Sigma_i\, G(u_i‡)\, \Delta u_i‡$ will usually be approximately equal to $\Sigma_i\, G(u_i)\, \Delta u_i$. If we define ε_0^1 by the relation

$$k_1 s_1‡s_2/k_2 s_2‡s_1 = 1 + \varepsilon_0^1 \tag{18}$$

we may anticipate that in any reaction involving C^{13} or C^{14} the values of ε_0^1 will not be greater than .12 and .25 respectively at room temperature. In any case the contribution of $\left(\frac{m_2}{m_1}\right)^{1/2}$ to ε_0^1 can usually be calculated and ε_0^1 can be approximated by setting $\Sigma_i\, G(u_i)\, \Delta u_i = \Sigma_i{}^1\, G(u_i‡)\, \Delta u‡$. This amounts to calculating the relative collision frequencies of gases. If an accuracy of this order of magnitude will suffice, then it is safe to assume that C^{13} and C^{14} are faithful tracers in both equilibrium

TABLE 1

ESTIMATED MAXIMUM RATIOS IN SPECIFIC RATE CONSTANTS AT 25° C

Stable isotope	Tracer isotope	$k_1 s_2 s_1‡/k_2 s_1 s_2‡$
H^1	H^2	18
H^1	H^3	60
Li^6	Li^7	1.1
Be^9	Be^7	1.15
Be^9	Be^{10}	1.08
B^{10}	B^{11}	1.3
C^{12}	C^{13}	1.25
C^{12}	C^{14}	1.5
N^{14}	N^{15}	1.14
N^{14}	N^{13}	1.14
N^{14}	N^{16}	1.25
O^{16}	O^{18}	1.19
F^{19}	F^{18}	1.25
N^{23}	Na^{22}	1.03
N^{23}	Na^{24}	1.03
Mg^{24}	Mg^{27}	1.08
P^{31}	P^{32}	1.02
S^{32}	S^{35}	1.05
Cl^{35} (natural abundance)	Cl^{36}	1.03
Cl^{37} (natural abundance)	Cl^{38}	1.14
Ca^{40}	Ca^{45}	1.08
I^{127}	I^{131}	1.02

and nonequilibrium systems. In quantitative work it will be necessary to determine ε_0[1] experimentally or to estimate it theoretically. In many experiments an appreciable fraction of the substrate is allowed to react. From equation (12) and Fig. 1 it is obvious that the isotope effect decreases with the amount of reaction and thus the isotope effects in the use of C^{13} and C^{14} will be even smaller than .12 and .25 respectively.

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Shielding of Syringes Used for Injecting Radioactive Solutions[1]

H. C. Dudley, J. F. Bronson, and R. O. Taylor

Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland

The delayed general effects of total body radiation, intermittant, subclinical, and of no apparent immediate significance, have had serious consequences for some radiologists and radium therapists (*3, 5*). The introduction of radioisotope therapy offers additional sources of exposure to these persons since they are, in general, best trained to handle the new tools. Similarly, lesions appearing on the hands of some radiologists later in life indicate the latent effects of localized ionizing radiations (*2, 4*).

During an investigation of the biological significance of radiogallium (Ga^{72}), it was found that for protection against the strong gamma spectrum (2.5 mev) of this isotope some type of remote central apparatus or some dense shield over a standard syringe was necessary. Because of the difficulty of using a remote control injection apparatus clinically, there have been designed and constructed two types of shields to be placed over syringes of standard stock sizes.

Fig. 1 presents details of construction of a two-piece Lucite shield adequate to protect the hands of persons injecting alpha emitters and beta emitters having energies less than 2 mev. This type of shield offers protection against the following isotopes: C^{11}, C^{14}, F^{18}, P^{32}, S^{35}, Cu^{64}, and Sr^{89}. It is emphasized that the isotopes listed here emit no gamma radiation. For those which do, the metal shield described in Fig. 2 must be used.

The design of the Lucite shield (Fig. 1) is similar to that described by Anthony and Norris (*1*), the essential difference being in arrangment for locking the needle in place by tightening the threaded top. This prevents loosening of the needle and subsequent leakage, which is a serious hazard when very active or long half-life isotopes are being injected.

[1] The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

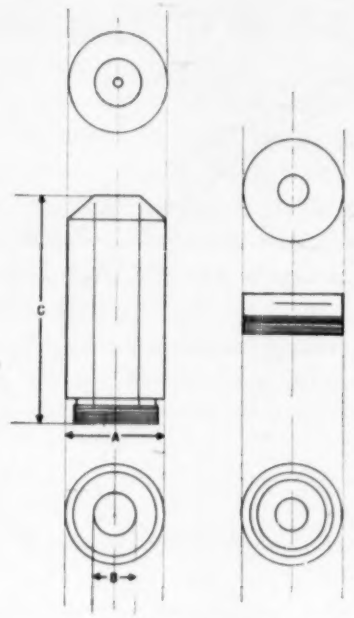

FIG. 1. Plastic syringe holder.

Dimensions:		A	B	C
Size	1/4 cc.	1 1/2 in.	5.5/16 in.	3 11/16 in.
"	1 "	1 "	3/8 "	2 15/16 "
"	5 "	1 3/16 "	10.5/16 "	4 "

Fig. 2 presents details of a metal syringe shield which has been constructed in sizes to fit all standard syringes from 1/4 cc to 30 cc. This piece of apparatus is made by filling an aluminum tube with a commercially available lead alloy (type metal—82 Pb, 12 Sb, 4 Sn), and machining to the dimensions shown in Fig. 2. The slot which is milled in the metal case, permits observation of liquid levels, absence of air bubbles, etc. To facilitate these observations, a dark colored solution is preferable and the inside surface of the shield is coated either with

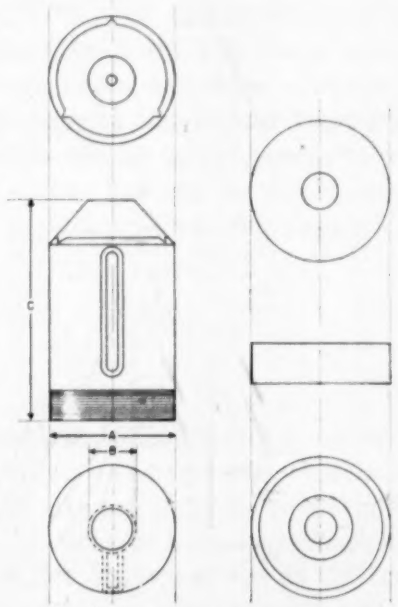

FIG. 2. Metal (Pb) syringe holder.

Dimensions:		A	B	C
Size	1/4 cc.	1 1/2 in.	5/16 in.	3 1/4 in.
"	1 "	1 1/2 "	3/8 "	4 3/16 "
"	5 "	2 "	3/4 "	3 3/4 "
"	10 "	2 "	7/8 "	4 3/4 "
"	20 "	2 1/2 "	1 "	5 1/2 "
"	30 "	3 "	1 1/8 "	6 3/4 "

a phosphor activated by radioactive emanations or by some luminous dial paint.

These shields have been used when studying the biological effects of radiogallium (Ga^{72}) which has an unusually energetic spectrum (β 3.1 mev, γ 2.5 mev). Persons wearing film badges and pocket electroscopes on the body and on the hands have received less than 20 milliroentgens (mr) total body radiation and less than 40 mr on the hands, when injecting solutions of 0.4 mc/ml activity, in quantities up to 4 mc per injection and a total of 25 mc.

The difficulties encountered in using shields of the types described are those of manipulation, due to their size and weight, particularly of the metal shields.

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Erroneous Ascorbic Acid Values Resulting from Interference by Anthocyanins

G. F. Somers, W. C. Kelly, E. J. Thacker, and Anna May Redder

U. S. Plant, Soil, and Nutrition Laboratory, Agricultural Research Administration, Ithaca, New York

The determination of ascorbic acid in anthocyanin-containing plant products presents special problems. If the usual indophenol dye reduction methods are used, the color due to anthocyanin is very similar to that of the dye in acid extracts. In highly colored extracts, it then becomes desirable to eliminate this color. This is easily accomplished by a xylene extraction of the excess dye following the reaction of the dye with ascorbic acid (*1*, *2*, *5*). Anthocyanins are not extracted by xylene under these conditions. This procedure has been used in the analysis of colored plant materials (*3*, *5*).

We attempted to use a xylene extraction method (*2*) for determining the ascorbic acid content of red beets. As previous workers had reported, it was found that the anthocyanin, betanin, was not extracted by xylene and hence did not interfere with the determination due to its color *per se*. However, analytical difficulties of another sort were encountered. It was found, for example, that aliquots of a single metaphosphoric acid extract of beet hypocotyl did not check if the aliquots were of different sizes. Also, similar metaphosphoric acid extracts containing different amounts of tissue per unit volume failed to give comparable results. When aliquots of such extracts were treated with formaldehyde (*6*), the capacity to reduce the dye was decreased to only about one-half its original value. Ascorbic acid is rendered nonreactive under these conditions, and in the absence of interfering substances formaldehyde-treated aliquots no longer reduce the indophenol dye. Hence, it was concluded that these extracts contained appreciable quantities of reducing substance (or substances) other than ascorbic acid. It was observed that this residual reducing capacity was closely correlated with the color of the metaphosphoric acid extracts (coefficient of correlation $= +0.724$, $n = 81$).

These observations led to an investigation of the extent of similar interference in other anthocyanin-containing products. In fresh fruits the amount of interference was found to be small; but in a number of fruits stored for months at 0° F, during which time the ascorbic acid largely disappeared, the amount of interference became relatively important.

In order to determine whether or not anthocyanins were the cause of the interference, an attempt was made to isolate various anthocyanins in more or less pure form and to study their reaction with the indophenol dye. It was found that betanin could be obtained in a somewhat concentrated form as follows: Fresh beets were sliced and frozen and the juice was pressed out; this juice was frozen and dried *in vacuo*. When the resulting powder was suspended in water and adjusted to about pH 3.5, the anthocyanin was precipitated by adding ethyl alcohol to give a concentration of about 80%. The precipitate was washed with 95% ethanol and then with acetone by centrifuging, and dried *in vacuo*. The resulting red powder was readily soluble in water and it reacted with the indophenol dye in much the same way as the interfering material present in extracts from fresh beets. Its reaction was not prevented by formaldehyde. Betanin isolated according to the procedure of Pucher *et al.* (*4*) reacted in a similar manner. Thus, it appears evident that the interfering material in extracts from fresh beets is the anthocyanin, betanin.

In view of these results, it seemed desirable to determine the antiscorbutic activity of the concentrated anthocyanin by means of a bioassay. Betanin was prepared from lyophilized beet juice by alcoholic precipitation as outlined above. This material was then assayed chemically and was fed to guinea pigs at the rate of 4 mg daily of apparent ascorbic acid (chemical assay) per animal. The bioassay selected was the depletion technique as used by Tressler, Mack, and King (*7*). From the results obtained it was concluded that the anthocyanin concentrate had no antiscorbutic activity for the guinea pig.

These results will be reported in greater detail elsewhere.

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Effect of Rutin on the Biological Potency of Vitamin C

E. W. Crampton and L. E. Lloyd

Department of Nutrition,
Macdonald College of McGill University,
Montreal, Canada

The biological potency of vitamin C in different natural sources has only recently become known, and subsequent findings require explanation. Work carried out in this laboratory has shown that the ascorbic acid of certain foodstuffs has a higher apparent biological value, at the lower levels of vitamin intake, than is shown by chemical assay. We have demonstrated in the case of fortified tomato juice and fortified orange juice, and with stored cabbage and dehydrated potato, that chemical methods of assay underestimated the biological potencies, as determined by the odontoblast method of assay. This evidence appears to support the hypothesis that a factor in natural vitamin C carriers increases the biological value of ascorbic acid beyond that expected from chemical analysis.

In the quest of this unknown factor, all evidence pointed to a substance with vitamin P activity. Griffith, Couch, and Lindauer (*2*) fed rutin, a flavonal glycoside, to 14 patients with hypertension, all of whom subsequently showed increased resistance in the capillary walls. This work was confirmed by Shanno (*3*). Ambrose and DeEds (*1*) administered rutin to rabbits, and found that it decreased cutaneous capillary permeability. Furthermore, Wilson, Mortarotti, and DeEds (*4*) showed that rutin prolongs the action of epinephrine on intestinal strips, the prolongation presumably being due to a protection of the epinephrine from oxidative destruction. Based on this information, we postulated that rutin might be one factor responsible for enhancing the biological potency of ascorbic acid in certain natural sources of the vitamin.

This note is a preliminary summary of an experiment carried out in this laboratory to ascertain the biological value of vitamin C in two natural sources of the vitamin, and to test the effect of added rutin on the apparent vitamin C potency of these substances, as well as on synthetic ascorbic acid. The assay included 96 guinea pigs, divided into three equal groups, each group containing equal numbers of both sexes. As the only source of vitamin C, the first or control group received crystalline ascorbic acid, the second group received canned orange-grapefruit juice, and the third group received dehydrated potato. Each assay material was fed at four different levels of vitamin C content, these levels being 0.5, 0.79, 1.26, and 2.00 mg of ascorbic acid per day. The amounts of orange-grapefruit juice and dehydrated potato to be fed were based on chemical analyses of samples of the two materials. Half the animals on each assay material were fed orally 100 mg per day of crystalline rutin.

Using the odontoblast method of assay, it was found that the rutin treatment gave significantly higher values on the response-dose curve at the 0.5, 0.79, and 1.26 mg levels of vitamin C intake for both the synthetic ascorbic acid and orange-grapefruit juice assays (Fig. 1). At the lower levels of vitamin intake, it appears that rutin either makes more available or delays *in vivo* destruction of ascorbic acid in the original source. A further distinct possibility is that rutin forms the basis for synthesis by the animals of additional ascorbic acid. This postulation follows from the similarity between the glucose-fructose side chain of the rutin molecule, and the actual structure of some of the many forms of ascorbic acid. Therefore, rutin, present in some natural vitamin C sources, might be considered to be the factor responsible for enhancing the apparent biological potency of vitamin C.

Because of the very low vitamin C content of dehydrated potato, it was impossible to get the animals, even

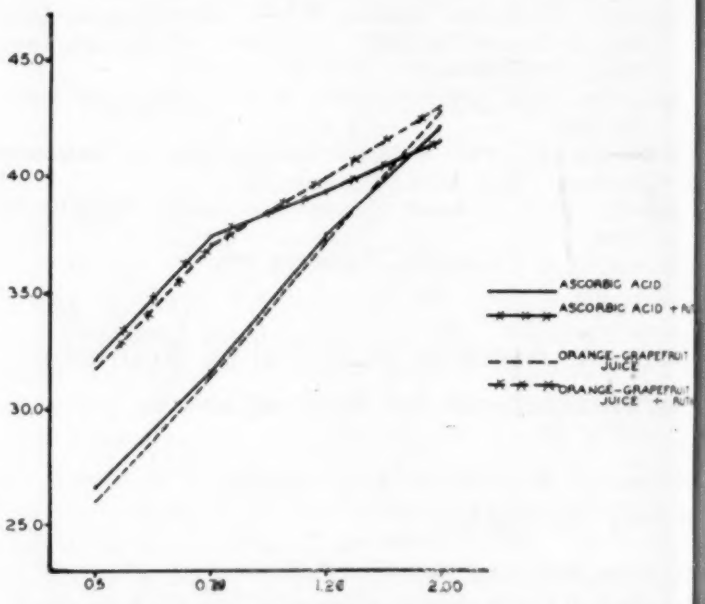

FIG. 1. Effect of supplementary rutin on the response of guinea pigs to increasing doses of vitamin C. Abscissas represent mg ascorbic acid/pig/day; ordinates represent odontoblast height in microns.

by forced feeding, to consume enough of this material to meet the necessary levels of ascorbic acid. This resulted in the death of approximately half of these animals due to advanced stages of scurvy with ultimate starvation. Since the intake of dehydrated potato was inadequate and inconsistent, the variability of the results obtained with the survivors was very high. For this reason it was thought inadvisable to include quantitative data on the findings in this report, although the effect of rutin was again apparently to raise the biological potency of vitamin C in the dehydrated potato.

It may be tentatively concluded that the enhanced biological value of vitamin C observed in this test is due to the flavonal glycoside, rutin. However, the mechanism of action of rutin is as yet undetermined.

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Preparation and Properties of Tridecanoic Acid Containing C^{14} in the Carboxyl Group

Edward Hines and Andrew Gemant

Research Department, The Detroit Edison Company

An organic electrolyte containing a radioactive isotope was required in order to carry out studies of mobilities and molecular sizes of ion-forming compounds in dielectric liquid (*2*), particularly insulating oils. A previous paper (*3*) indicated that any aliphatic acid having a molecular weight equal to or greater than that of propionic acid is suitable for obtaining the electrical conductivity necessary. The further requirement of low vapor pressure, to minimize contamination of the laboratory atmosphere with radioactive vapor, limited the range to acids of molecular weight greater than that of capric acid. Consideration of these requirements of the compound, the means of preparing it, and the available starting materials led to the selection of tridecanoic acid containing C^{14} in the carboxyl group.

The tridecanoic acid was prepared from lauryl bromide and carbon dioxide by the Grignard reaction, the carbon dioxide being obtained by acidification of barium carbonate containing C^{14}. Unlike the usual carbonation of Grignard reagents, this reaction necessitated the use of an excess of Grignard reagent rather than an excess of carbon dioxide, because of the expense of the radioactive isotope used. Since the use of excess Grignard reagent favors the formation of secondary products, such as ketones and alcohols (*4*), the carbonation and subsequent hydrolysis were carried out as rapidly as possible.

Purification from secondary products was carried out by saponification and reprecipitation of the acid.

The purified acid crystallized as white plates, having a melting point of 39.5° to 41.5° C. This compares with 40.5° C found by Krafft (*5*), 40° C by Blau (*1*), and 42.5° C by Le Sueur (*6*). The refractive index was found to be 1.427 n_D at 60° C, which is in close agreement with the value of 1.4249 n_D at 70° C obtained by Waterman and Bertram (*9*). Values of 72.8% carbon and 12.4% hydrogen were obtained by ultimate analysis. These values approximate the theoretical values of 72.8% carbon and 12.2% hydrogen.

The apparatus used for the carbonization of the Grignard reagent consisted of a generating flask, drying tube, and reaction flask, interconnected in the order named. The generating flask contained barium carbonate (0.024 mole) having 2 mc of C^{14}. The radioactive barium carbonate was purchased from the United States Atomic Energy Commission. The drying tube contained anhydrous calcium chloride and the reaction flask contained the Grignard reagent prepared from lauryl bromide. This system was evacuated prior to the carbonation so that a partial vacuum would exist in the apparatus throughout the synthesis, thus preventing the leakage of radioactive vapors into the laboratory atmosphere.

Carbon dioxide was generated from the barium carbonate at such a rate as to keep gas pressure in the system constant at slightly below atmospheric pressure. It was passed through the drying tube into the reaction flask as it was generated and, upon completion of the acidification of the barium carbonate, the carbon dioxide remaining in the system was flushed into the reaction flask with small charges of dry nitrogen until the system had reached atmospheric pressure. The contents of the reaction flask were then hydrolyzed in the usual manner on crushed ice.

The entire reaction from the beginning of the carbonation to the completion of the hydrolysis was carried out within 5 min.

One gram of the product was melted and spread over an area of 20 cm^2, then permitted to crystallize, yielding a layer of about 0.05 cm in thickness. An open area of 4.7 cm^2 was screened out for a count test with a Geiger-Müller counter having a mica window 2.54 cm in diameter and 2.8 mg/cm^2 in thickness. The distance between the sample and the mica window was 9.1 cm. The net counts obtained were 28/sec.

In order to compare this figure with the theoretically expected count, the latter was computed in the following manner. The upward activity I of a layer of thickness ρ g/cm^2, an area of A cm^2, and containing σ mc/g, corresponds to

$$I = \frac{A\sigma}{2\mu}(1 - e^{-\mu\rho})$$

where μ = absorption coefficient in cm^2/g of the radiation in question (*7*). If ρ equals or is larger than the range of the betas, the exponential term becomes zero and the bracket is unity. This was the case in this test, since the range of 0.14-Mev betas is 20 mg/cm^2.

From the chemical synthesis, 2 mc of C^{14} should be present in about 0.024 mole of tridecanoic acid, i.e., in 5.2 g of the acid. In other words, $\sigma = 0.39$ mc/g. With $\mu = 270$ cm^2/g for the electrons of radioactive carbon (*8*), we have $I = 0.0034$ mc, or, converted into counts, 1.25×10^5 counts per sec.

From the geometry of the arrangement, the spatial angle (in terms of 2π) that the mica window represents in $1 - \cos \tan^{-1}(1.27/9.1) = 0.0097$. Hence the counts corresponding to this spatial angle are 1200 per sec.

The mass of air between the sample and the counter is 10.9 mg/cm^2, to which must be added the mass of the mica window, giving 13.7 mg/cm^2. The relative intensity of betas escaping absorption is then $\exp(-270 \times 13.7 \times 10^{-3}) = 0.024$. The number of betas that should reach the counter is then 29 per sec. This is in good agreement with the experimentally obtained value of 28 per sec.

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Book Reviews

Cancer: radiations, virus, environment. (Vol. II.) J. Maisin. Paris, France: Casterman, 1949. Pp. 306. 120 fr.

Volume II, comprising Chapters V to VII of Dr. Maisin's treatise on cancer, is a critical review of the literature on the relationship of radiations, viruses, and environment to cancer.

The importance, in the etiology of cancer, of various agents, such as X-rays, radioactive substances, ultraviolet light, certain animal parasites, coal tar, and some hydrocarbons which produce prolonged or chronic irritation is now generally recognized. Cutaneous contact with solar rays or X-rays causes cancer of the skin. Inhalation of radioactive substances causes cancer of the lung. Ingestion of radioactive substances causes cancer of the bone. These phenomena belong to the category of environmental cancer. Dr. Maisin believes that cancerization by these rays, whether internal or external, is the result of mutation of normal cells into neoplastic cells. Another characteristic property of all the cancers caused by radiation is a long period of latency. In man, this period is from 10 to 20 years (from the last irradiation to the onset of the cancer). It seems, therefore, that the cell which has undergone mutation rests dormant for years without division. The altered gene, one could call a mutagene. The atomic bombs that wiped out the cities of Hiroshima and Nagasaki in 1945, although they spared a certain number of humans, different species of animals, and numerous plants, have tragically placed these survivors under ideal experimental conditions for the study of the mutagenic action of penetrating rays. All have been largely irradiated with sublethal doses of α, ß, and γ rays. It will be of greaf value to observe what becomes of their descendants. The accident having occurred, it will be a pity if science cannot profit from it.

It is now well recognized that cancer in animals can be caused by parasites *Gongylonema neoplasticum*, and *Cysticercus fasciolaris*, and by viruses—Rous chicken sarcoma, Fujinami fowl myxosarcoma, Shope rabbit papilloma, Lucké frog kidney carcinoma, Bittner mouse breast cancer, and Yoshida rat ascites sarcoma. (YOSHIDA, T., MUTO Y., and SASAKI Z. *Proc. imp. Acad., Tokyo*, 1944, *20*, 611. Note by K. Sugiura.) However, there is no evidence that cancer in man is caused by parasites or viruses, although this assertion has been made frequently. Carcinogenic parasites or viruses themselves would not be able to initiate a malignant tumor if the environment and genetic factors of the host were not favorable.

Although cancer is not properly termed an hereditary sickness, heredity plays an important role in the genesis of cancer. In certain types of cancer, hormone influence also plays a role in the formation of malignancy. Without this hormonal influence, in spite of heredity, these cancers will not appear. The influence of external environment in the development of human cancer has long been recognized. Percival Pott, in 1775, noted that cancer of the scrotum was unusually common among chimney sweeps. Subsequently, various environmental or occupational cancers have been described. Thus cancer of the skin, lung, and bone by contact with radioactive substances and X-rays; cancer of the scrotum, face, hands, bladder, and liver by contact or ingestion of hydrocarbons; and skin cancer by solar rays. Thus a number of human cancers are known to be of extrinsic origin, but a substantial proportion can be prevented by environmental control in industry.

Finally, Dr. Maisin hopes for discovery of a "penicillin or sulfonamide" for cancer cells. He thinks, however, that the discovery of a carcinolytic substance is further off than the means for the ultimate prevention of cancer.

Dr. Maisin deserves to be congratulated for this valuable addition to cancer literature, and students of cancer may greatly profit from it. The bibliography includes 739 papers, written by 626 individuals and joint authors. The first four chapters, treating the subject of heredity, hormones, and carcinogenic substances, form Volume I of this work.

KANEMATSU SUGIURA
Sloan-Kettering Institute for Cancer Research

Human ancestry from a genetical point of view. R. Ruggles Gates. Cambridge, Mass.: Harvard Univ. Press. 1948. Pp. xvi + 422. (Illustrated.) $7.50.

Nowadays a book on human evolution has a definite reader appeal. This fact imposes on the author a demand for a generally high level of performance—quite apart from his obligation to anthropology, to the reader, and to clear, simple writing. We have every right to expect authoritative reporting and objective interpretation. There are certain descriptive facts concerning fossil man and modern races that are the common possession of the literature in this field and these can be brought together with reasonable facility. It is not so much, therefore, the assembling as the interpreting that becomes important.

Human ancestry does not fulfill this demand. It is unevenly written; one has the feeling that it was written in spurts, with parts, or even whole chapters, inserted as afterthought. Well-established evolutionary concepts are presented almost as though they were unique to the present volume. For example, much is made of "parallel evolution" as a relatively neglected avenue of interpretation; yet Le Gros Clark for the Primates and Olson for the mammals have developed this theme in precise detail.

The lay reader will be dismayed by the interjection into an acceptable literary style of very technical botanical and zoological material as evidence to support sweeping generalizations. The result is rather like encountering a number of road repair and detour signs along a fine concrete highway.

Prof. Gates insists that there are five species of living *Homo: H. australicus, H. capensis, H. africanus, H. mon-*

goloideus, and *H. caucasicus*. In so doing he chooses to disregard the concept of mutual interfertility. He neglects also the earlier statement of Georges Puchet (*ca.* 1860) that "either we must admit different species in the genus *Homo*, or we must entirely revise zoological classification."

This reviewer is not so much concerned with the establishment of five human species as with the attitude, the conceptual values, behind it. The whole thing has an air of a racial (specific) hierarchy, a "superior-inferior" categorization. The sequential build-up is clear: "This eighteenth century political doctrine [that 'all men are born free and equal'] is hopelessly at variance with the facts of science. . . ." (p. 114); "there is no question of the inheritance of mental abilities and disabilities" (p. 145); " . . . the mental differences between races remain and cannot be gain-said" (p. 367). The reader is led, even though perhaps unconsciously, into a racist patterning of thought, both culturally and biologically.

The fact that this is a "bad" book is, in a sense, beside the point. What really matters is that it is *not* a "good" book. It should have been; with more care and objective thinking it could have been.

WILTON MARION KROGMAN
Graduate School of Medicine,
University of Pennsylvania

Cosmic ray physics. D. J. X. Montgomery. Princeton, N. J.: Princeton Univ. Press, 1949. Pp. viii + 370. (Illustrated.) $5.00.

A great number of physics students are nowadays turning to the subject of cosmic rays, and for some years there has been a serious need for a textbook to introduce the subject to them in their first or second year of graduate study. The need has been particularly urgent because of the lamentable state of periodical literature on cosmic rays. There is a bewildering profusion of articles on the subject—articles written in many languages, scattered throughout many journals, and full of mistakes and contradictions that a beginning student cannot be expected to sort out for himself.

Cosmic ray physics, by D. J. X. Montgomery, fills the need for such a textbook reasonably well and therefore will be heartily welcomed. It is easier to read than the recent book *Cosmic rays*, by L. Janossy (Oxford, 1948), and it is much more accurate and up-to-date than the few earlier books. Its major emphasis is on the principles underlying cosmic-ray experiments and the interpretation of experimental results. In contrast to Janossy's book, theoretical calculations are in general omitted, although the theoretical methods are broadly sketched in a qualitative fashion and some of the results of theoretical calculations are presented. The book offers little in the way of original contribution or information not published elsewhere, but is rather a survey of the cosmic-ray work up to 1948. One of its outstanding features is its exhaustive lists of references.

Montgomery's book was begun on the basis of a series of lectures on cosmic rays given by Marcel Schein at Princeton in 1946. Since then, however, the volume has been much amplified; many more recent experimental results have been incorporated, and notable contributions have been made by Niels Arley and by the late Shuichi Kusaka. Thus the author has been guided by specialists in both the experimental and theoretical branches of the subject.

There are, unfortunately, some errors in the book, and the author has occasionally taken a too credulous attitude towards an experiment or a theory. The references sometimes make no distinction between good work and bad. These, however, are not general characteristics. More commonly, Montgomery has adopted a healthy, critical view of published results, and has successfully weeded out errors. The occasional one remaining may serve as a teaching aid by stimulating students to read more carefully and critically than they would if they expected the text to be infallible.

KENNETH GREISEN
Cornell University

The pulsation theory of variable stars. Svein Rosseland. New York: Oxford Univ. Press, 1949. Pp. viii + 152. (Illustrated.) $5.00.

The wealth of unanswered questions regarding the giant stars in general and the pulsating giants in particular has attracted many astronomers in recent years to work on stellar pulsations. This work, however, has not yet given final answers to most of the essential questions. Under these circumstances the task of summarizing the present status of the pulsation theory is both extremely useful and very difficult; useful, because it may do much to stimulate the further research that is needed, and difficult, because definite facts are few to report, and many parallel investigations must be described whose relative values cannot yet be ascertained. Professor Rosseland has undertaken this task in spite of its difficulties and has completed it with singular success.

The first three chapters of the book contain the history and the basic elements of the pulsation theory. The following chapters describe the more recent developments, such as pulsational stability, the form of the pulsations in the outer parts of a star, and the effects of the nonlinearity of the basic equations. These topics are presented in a uniform and elegant mathematical form. The reading of these chapters may seem to require an appreciable effort. However, this effort should be small compared with that necessary to understand some of the original papers. The final chapter presents a comparison of the present pulsation theory with the observational data on certain critical points.

The chapter next to the last contains a discussion of shock waves. Since the book was published, the timeliness of this discussion has been amply demonstrated: new observational evidence obtained at the Mt. Wilson Observatory indicates that for some stars the pulsation in the atmosphere does indeed take the form of a shock wave.

MARTIN SCHWARZSCHILD
Princeton University Observatory

Scientific Book Register

ADAMS, LEVERETT A., and EDDY, SAMUEL. *Comparative anatomy.* New York: John Wiley, 1949. Pp. vii + 520. (Illustrated.) $5.00.

ALEXANDER, A. E., and JOHNSON, P. *Colloid science.* (2 vols.) London: Oxford Univ. Press, 1949. Vol. 1: pp. xx + 554; vol. 2: pp. viii + 555–837. (Illustrated.)

BAILEY, VIRGINIA LONG, and BAILEY, HAROLD EDWARDS. *Woody plants of the Western national parks: containing keys for the identification of trees and shrubs.* (American Midland Naturalist, monograph no. 4.) Notre Dame, Ind.: Univ. Press, 1949. Pp. 274. (Illustrated.)

BARTH, LESTER GEORGE. *Embryology.* New York (16): Dryden Press, 1949. Pp. xii + 330. (Illustrated.) $5.00.

BARTRAM, EDWIN B. *Mosses of Guatemala.* (Fieldiana: Botany, Vol. 25.) Chicago: Chicago Natural History Museum, 1949. Pp. v + 442. (Illustrated.) $4.00.

BLACKBURN, JOHN F. (Ed.). *Components handbook.* (Vol. 17.) (Massachusetts Institute of Technology Radiation Laboratory Series.) New York: McGraw-Hill, 1949. Pp. xvii + 626. (Illustrated.) $8.00.

BOOKMILLER, MAE M., BOWEN, GEORGE LOVERIDGE, and BAKWIN, HARRY. *Textbook of obstetrics and obstetric nursing.* Philadelphia: W. B. Saunders, 1949. Pp. xvii + 737. (Illustrated.)

CHANCE, BRITTON, *et al. Electronic time measurements.* (Massachusetts Institute of Technology Radiation Laboratory Series.) New York-London: McGraw-Hill, 1949. Pp. xviii + 538. (Illustrated.) $7.00.

CRILE, GEORGE, JR. *Practical aspects of thyroid disease.* Philadelphia: W. B. Saunders, 1949. Pp. xviii + 355. (Illustrated.) $6.00.

DENNIS, WAYNE, *et al. Current trends in social psychology.* Pittsburgh: Univ. Pittsburgh Press, 1948. Pp. vi + 299. $4.40.

FAULKNER, T. EWAN. *Projective geometry.* New York: Interscience; Edinburgh-London: Oliver and Boyd, 1949. Pp. viii + 128. (Illustrated.) $3.00.

HARNWELL, GAYLORD P. *Principles of electricity and electromagnetism.* (2nd ed.) New York: McGraw-Hill, 1949. Pp. xvi + 670. (Illustrated.) $6.00.

HARRIS, ROBERT S., and THIMANN, KENNETH V. (Eds.) *Vitamins and hormones: advances in research and applications.* (Vol. VI.) New York: Academic Press, 1948. Pp. xi +435. $7.80.

HEPLER, OPAL E. *Manual of clinical laboratory methods.* (4th ed.) Springfield, Ill.: Charles C. Thomas, 1949. Pp. xv + 387. (Illustrated.) $8.50.

HOLLINGWORTH, HARRY L. *Psychology and ethics: a study of the sense of obligation.* New York: Ronald Press, 1949. Pp. ix + 247. $3.50.

HOOD, SAMUEL STEVENS. (Ed.) *Archibald Henderson: the new Crichton.* New York 7: Beechhurst Press, 1949. Pp. xviii + 252. (Illustrated.) $5.00.

INGLIS, DAVID RITTENHOUSE. *Dynamic principles of mechanics.* Philadelphia: Blakiston, 1949. Pp. x + 174. (Illustrated.) $4.00.

JENKINS, GLENN L., DUMEZ, ANDREW G., and CHRISTIAN, GEORGE P. *Quantitative pharmaceutical chemistry.* (3rd ed.) New York-London: McGraw-Hill, 1949. Pp. xii + 531. (Illustrated.) $4.75.

KRAMER, MARY EVERIST. (Ernest A. W. Sheppard and Louisa Wells-Kramer, eds.) *Clinical orthoptics: diagnosis and treatment.* St. Louis: C. V. Mosby, 1949. Pp. 475. (Illustrated.) $8.00.

LATON, ANITA DUNCAN, and POWERS, SAMUEL RALPH. *New directions in science teaching: a report of a cooperative project in seventeen secondary schools with the Bureau of Educational Research in Science, Teachers College, Columbia University.* New York-London: McGraw-Hill, 1949. Pp. xi + 164. $2.50.

LEFSCHETZ, SOLOMON. *Introduction to topology.* Princeton, N. J.: Princeton Univ. Press, 1949. Pp. viii + 218. (Illustrated.) $4.00.

LOTHIAN, G. F. *Absorption spectrophotometry.* (3rd ed. of Twyman and Allopp's *The practice of absorption spectrophotometry with Hilger instruments*). Boston (16), Mass.: Jarrell-Ash; London (N.W.1), Engl.: Hilger and Watts, 1949. Pp. 196. (Illustrated.) $7.60 postpaid.

MACLEOD, COLIN M. (Ed.) *Evaluation of chemotherapeutic agents: symposium held at the New York Academy of Medicine, March 25 and 26, 1948.* New York: Columbia Univ. Press, 1949. Pp. xii + 205. $4.00.

MONIER-WILLIAMS, G. W. *Trace elements in food.* New York: John Wiley, 1949. Pp. viii + 511. $6.00.

MORGAN, BANNER BILL, and HAWKINS, PHILIP A. *Veterinary helminthology.* Minneapolis 15, Minn.: Burgess Publ., 1949. Pp. 400. (Illustrated.) $7.00.

PEASE, KATHARINE. *Machine computation of elementary statistics.* New York 16, N. Y.: Chartwell House, 1949. Pp. 238. (Illustrated.) $2.75.

PETERS, HANS M. *Grundfragen der Tierpsychologie: Ordnungs- und Gestaltprobleme.* Stuttgart, Germany: Ferdinand Enke, 1948. Pp. viii + 117. (Illustrated.) 1 F.

QUARLES, GILFORD G. *Elementary photography.* (2nd ed.) New York: McGraw-Hill, 1948. Pp. xii + 345. (Illustrated.) $4.50.

VON BERTALANFFY, LUDWIG. *Das biologische Weltbild: Die Stellung des Lebens in Nature und Wissenschaft.* (Band 1). Berne, Switzerland: A. Francke Ltd., 1949. Pp. 202. 11 fr., (Swiss); 14.50 fr., cloth-bound.

YAGODA, HERMAN. *Radiactive measurements with nuclear emulsions.* New York: John Wiley, 1949. Pp. ix + 356. (Illustrated.) $5.00.

———. *Index to the literature of experimental cancer research 1900–1935.* Philadelphia: Donner Foundation, 1948. Pp. xii + 1057. $10.00.

NEWS and Notes

G. E. Hutchinson, of Yale University, is travelling in Europe on a Guggenheim fellowship during the summer and fall. He expects to visit limnological laboratories in Great Britain, Norway, and Sweden and will spend some time at the Instituto Italiano d'idrobiologia at Pallanza.

C. P. Boner, professor of physics and director of the Defense Research Laboratory at the University of Texas, has been appointed dean of the College of Arts and Sciences, effective September 1. Dr. Boner succeeds **H. T. Parlin,** who will become dean emeritus at that time. Dr. Boner will continue his work at the Defense Research Laboratory on a part-time basis.

Ernest Sachs, professor emeritus of neurological surgery, Washington University, St. Louis, has been appointed research associate in physiology at Yale University.

John Eberhart, chief psychologist of the Training and Standards Branch of the National Institute of Mental Health, has been appointed director of research projects for the institute, effective July 1. Dr. Eberhart succeeds **Lawrence Kolb,** who has accepted a position as consultant in psychiatry at the Mayo Clinic.

Richard H. Shryock has been appointed director of the Institute of the History of Medicine and William H. Welch Professor of the History of Medicine at the Johns Hopkins University School of Medicine, effective in September. He is now professor of American history at the University of Pennsylvania.

E. C. Raney, associate professor of ichthyology at the Cornell University Department of Conservation, has been engaged by the Saltwater Sportsmen and the Massachusetts Fish and Game Association to spend the summer collecting and organizing information on the striped bass and to outline research on this species. Dr. Raney will visit research centers from Maine to North Carolina.

C. Donnell Turner, chairman of the Department of Biology, Utica College of Syracuse University, has accepted a visiting professorship in biology at the University of Rangoon. He expects to sail for Burma in July.

John E. Davis recently retired as head of the Department of Physics, William Jewell College, Liberty, Missouri. He has been a faculty member since 1907 and head of the department since 1912. He continues as professor of physics, and is succeeded by **Wallace A. Hilton** as head of the department.

Claude A. Villee, of the Department of Biological Chemistry, Harvard Medical School, who was awarded a Guggenheim Memorial Foundation fellowship for 1949–50, will study nucleoprotein metabolism at the Carlsberg Laboratory in Copenhagen with K. Linderstrom-Lang.

Visitors to U. S.

C. V. Robinow, of the Strangeways Research Laboratory, Cambridge, England, has been appointed visiting professor in the Department of Biological Sciences at Purdue University for the coming summer session. Dr. Robinow, whose field is the cytology of bacteria, particularly the nuclear structure of bacteria, will offer a course in experimental microbiology to graduate students.

Mary L. Cartwright, of the Department of Mathematics, Girton College, Cambridge, recently returned to England after an extended lecture tour in this country. At the invitation of Solomon Lefschetz, Dr. Cartwright spent three months at Princeton University as consultant on his differential equation project, which is sponsored by the Office of Naval Research.

Frederick Baltzer, professor of biology at the University of Bern, Switzerland, has been visiting the University of Colorado Medical Center at Denver, where he presented discussions of his experiments on the development of hybrid transplants in amphibians to the staff seminar on fundamental biology. Dr. Baltzer sails for Switzerland on July 7.

Leonce Bonnefil, chief of the Section of Zoology and Entomology, Department of Agriculture, Port-au-Prince, Haiti, arrived June 16 for a three-month stay. While here, he will confer with experts in the field of fish and wildlife conservation.

Recent visitors at the National Bureau of Standards were **F. W. Thomas,** head of the Technical Processing Department of the British Cotton Industry Research Association, Shirley Institute, Manchester, England; **R. C. Bevan,** principal scientific officer, Building Research Station, Department of Scientific and Industrial Research, Watford, England; **Shragga Irmay,** senior assistant and instructor at the Hydraulics Laboratory, Hebrew Institute of Technology, Haifa, Israel; **R. M. Wilcox,** Department of Physics, University of Toronto, Canada; **R. S. Airs** and **J. B. Mathews,** Shell Petroleum Company, Ltd., Thornton, England; and **L. M. Clark** and **H. E. Jones,** Imperial Chemical Industries, Ltd., Norwich, England.

Grants and Awards

The Old Dominion Foundation, established by Paul W. Mellon, has awarded $2,000,000 apiece to Yale University and Vassar College. The gift to Yale is to be used to expand its student psychiatric guidance program, which will be directed by Clements C. Fry, head of the Division of Psychiatry and Mental Hygiene of the university's Department of Health. Vassar will use the donation to establish the Mary Conover Mellon Fund for the Advancement of Education. This counseling program will be directed by Carl Binger, psychiatrist and member of the faculty of the Cornell University Medical College.

The Charles Lathrop Pack Forestry Foundation has donated $100,000 to the University of Michigan to establish a course of study leading to a master's degree in conservation. The gift will be made in grants of $10,000 a year.

The Association for the Study of Internal Secretions, at its thirty-first annual meeting in Atlantic City on June 3–4, presented the E. R. Squibb and Sons Award to Herbert M. Evans; the Ciba Award to George Sayers; the Ayerst, McKenna, and Harrison Fellowship to Ernest M. Brown, Jr.; and the Schering Fund Fellowship to D. Lawrence Wilson.

A five-year grant for research in the cause and prevention of retrolental fibroplasia has been established by the **Dunlevy Milbank Foundation Inc.,** at the Columbia-Presbyterian Medical Center, New York City. The research will be directed by John Dunnington, director of the Ophthalmological Service at the center. Algernon B. Reese, attending ophthalmologist and pathologist, will be in direct charge of the project.

Seale Harris, of Birmingham, Alabama, was awarded the **Distinguished Service Medal** by the American Medical Association at its meeting in Atlantic City. Dr. Harris is best known for his research on hyperinsulinism and its control.

The Charles A. Coffin Award—a gold medal and $1,000—was granted to the Union Electric Company of Missouri at the annual convention of the Edison Electric Institute. The award is made annually for outstanding achievement among privately owned utilities.

Fellowships

A fellowship leading to an M.S. degree in chemical engineering at the Illinois Institute of Technology will be given by the Chicago Paint and Varnish Production Club and the Chicago Paint and Lacquer Association for the academic year 1949–50. Based on competitive examination, the fellowship will grant $1,000, plus $550 tuition for two semesters to the winner. Applications should be sent to William A. Lewis, dean of the Graduate School, Illinois Institute of Technology, Chicago 16, before *July 15.*

The American Heart Association announces the availability of fellowships for research and established investigations in cardiovascular disease. Applications must be filed not later than *September 15.* Applications for a limited number of grants-in-aid for research studies in the cardiovascular field and in basic research will be accepted until *December 15.* If both fellowship and grant-in-aid are desired, the two applications should be filed together. Further information and application blanks may be obtained by writing the Medical Director, American Heart Association, 1775 Broadway, New York 19.

Colleges and Universities

The University of Toledo will offer a graduate program in glass technology beginning in 1949–50. The program will be open to students with a B.A. in chemical engineering, chemistry, or physics. Inquiries regarding the program should be directed to Walter V. Burg, Department of Chemical Engineering, University of Ohio, Toledo 6, Ohio.

A series of eight weekly lectures on the history of science will begin July 5 at the **University of Chicago.** Lecturers will include visiting professors Willy Hartner, director of the Institute of History of Science, and Karl Reinhardt, professor of classical philology, both of the University of Frankfort; and H. B. Acton, professor of philosophy, University of London. University of Chicago faculty members who will participate are John A. Wilson, professor of Egyptology and associate director of the Oriental Institute; Leo Strauss, professor of political philosophy; Earl A. Evans, Jr., professor and chairman, Department of Biochemistry; Enrico Fermi, professor of physics; and Charles C. Colby, professor and chairman, Department of Geography.

The University of Wisconsin has announced two symposia to be held during its centennial program: "Mineral Nutrition of Plants"—September 1–3; and "Plant Growth Substances"—September 5–7. Detailed information may be had from R. P. Lee, Division of Residence Halls, Slichter Hall, University of Wisconsin, Madison 6.

Meetings and Elections

The Second International Audiology Conference will be held in London at the Royal Society of Medicine, July 15–16. Interested professional specialists are invited to the open meeting on July 16.

The 12th International Dairy Congress will be held at Stockholm, Sweden, August 15–19, for the purpose of reviewing developments and exchanging technical information in the field of dairy research. The United States, although not a member of the International Dairy Federation, has been represented at the last three congresses and this year will send a delegation of ten, headed by Ollie E. Reed, chief of the Department of Agriculture's Bureau of Dairy Industry.

The 47th meeting of the **Congress of French Psychiatrists and Neurologists** will be held at Clermont-Ferrand, September 12–18. The major topics will be the reactive psychoses; the consequences of occipital lobe surgery; and medicolegal psychiatry. The general secretary of the Congress is Dr. Paul Cossa, 3 Bd. Victor Hugo, Nice, France.

Centre National de la Recherche Scientifique announces that a colloquium on **Algebra and the Theory of Numbers** will be held in Paris, September 23–October 1. U. S. scientists invited to attend are: Oscar Zariski, Harvard University; Emil Artin, Princeton University; Garrett Birkhoff, Harvard University, and André Weill, University of Chicago.

The 31st National Metal Congress and Exposition will be held in Cleveland's Public Auditorium, October 17–21. "Economy in Production" will be the theme, and exhibits are planned to demonstrate what modern industrial equipment can do to effect savings in cost production.

The 1949 meeting of the **History of Science Society** will be held in conjunction with the annual meeting of the **American Historical Association** at Boston late in December. Plans are now being made for

program, and members of the society interested in submitting papers for consideration should communicate with the Chairman of the Program Committee, Professor Henry E. Guerlac, Cornell University, Ithaca, New York. No papers can be considered after *October 1*.

The Electrochemical Society elected the following officers at its recent annual meeting held in Philadelphia: Alfred L. Ferguson, professor of chemistry, University of Michigan, president; J. C. Warner, dean of Graduate Studies and head of the Chemistry Department, Carnegie Institute of Technology, vice president.

A Conference on Scintillation Counters was held in Oak Ridge on June 3 and 4. This was the second in a series of conferences sponsored by the Oak Ridge National Laboratory; the first was the low temperature symposium held last summer. The scintillation conference was attended by approximately 175 people, including 125 out-of-town visitors from universities, industries, and government agencies throughout the country.

The first day was devoted chiefly to four lectures. H. Kallmann, of the Signal Corps Laboratories, reported on the work that led to his discovery that naphthalene could be used in conjunction with a photomultiplier to count beta particles. He also described his subsequent investigations of other phosphors. F. Seitz, of Carnegie Institute of Technology, discussed the possibility of obtaining crystals that would exhibit multiplication properties similar to a Geiger counter. George Morton, of the RCA Research Laboratories, reviewed the design and characteristics of present-day photomultiplier tubes, particularly with reference to scintillation counting. P. R. Bell, physicist at the Oak Ridge National Laboratory, described his scintillation spectrometer and showed examples of its use for measuring the beta spectrum of several isotopes. This apparatus was demonstrated at the conclusion of the session.

More than a hundred members attended a dinner, after which Dr. Kallmann told about some of his work at the Kaiser Wilhelm Institute, and the tremendous difficulties he had in getting apparatus.

The second day's session was devoted to a discussion of the various aspects of scintillation counting. Several experiments in which scintillation counters were the primary tool were described. R. Hofstadter showed that gamma rays are scattered as predicted by the Klein-Nishina formula. L. F. Wouters described some of the work going on at Berkeley with fast neutrons and protons. Martin Deutsch gave an account of his work on the time of decay of the positron in various gases. Most of the day was spent in discussing photomultiplier tubes, phosphors, light collectors, and electronic circuits.

Martin Deutsch, of MIT, served as chairman of both sessions.

W. H. JORDAN

NRC News

The NRC Committee on Unesco held its semiannual meeting at Spring Mill State Park, Indiana on June 3 and 4. The whole science program of Unesco was examined and certain specific recommendations were made with regard to present and future activities.

In preparation for the current Conference on Scientific Abstracting under the sponsorship of Unesco, the committee made the specific recommendation that Unesco should subsidize two or more agencies to distribute promptly and economically reliable abstracts covering the world's literature in biology and medicine. Initial emphasis is placed on biology and medicine because Unesco has learned much in the past two years about factors that have hindered progress in this area, and further because Unesco's Committee on Biological and Medical Abstracting can readily outline a detailed program for immediate action. A concerted attack upon the problem for a limited area is favored over an attempt to establish in the near future an over-all coordinating office for scientific abstracting.

The committee endorses the existing Unesco program of grants-in-aid to the international scientific unions, and urges its continuation. It urges in addition that the United States Government make available adequate funds for travel expenses of its representatives to international meetings so that they will be chosen because of their scientific standing and the contribution that they can make to a professional meeting, rather than because they individually are able to finance their travels. It is suggested that a minimum of 25 percent of the funds provided for United States representation be used to finance the attendance of scientists under thirty-five years of age.

The committee formally accepted a report submitted to the Department of State recommending that a limited number of United Nations research laboratories be established in the near future. The committee recommends immediate favorable consideratoin of three projects: an international computational center or a mathematical and statistical consulting center, to be established somewhere in Central Europe; an institute for individual and social psychology, working directly with the United Nations; and an institute of geomedicine, the latter possibly as a joint project for Unesco and the World Health Organization.

The committee learned with regret that certain difficulties have arisen with regard to the formal ratification of the agreement for the establishment of the International Institute of the Hylean Amazon. The Committee urges the U. S. National Commission for Unesco to use its good offices in investigating the reasons for the delay and in promoting healthy conditions for the growth and development of this institute, which should be a model of Unesco's work.

The committee expressed a deep interest in the new Technical Assistance Program of the Economic and Social Council of the United Nations and approved the way in which Unesco is collaborating in this important activity. The committee urged that the local population should be given important responsibilities in the execution of the program and that careful attention be paid to the effect of the assistance upon the cultural, political and social

conditions of the population. It urged further that in the agricultural and industrial training program, full advantage be taken of experience gained through existing projects, and that in technical training programs emphasis be put on the development of small rural industries and on teaching by the apprentice method. Attention was drawn to the importance for wide areas of the world of improving fishing methods and handling of the catch. The committee recommended that, to supplement the local technical training programs, opportunities for further training at home and abroad should be provided for technicians who show marked ability. It is hoped that Unesco will emphasize those phases of the program which involve participation or cooperation of several countries and that colonial and minority people may have a voice in the program through the Trusteeship Council of the United Nations.

In a letter addressed by the committee to the chairman of the National Research Council, the suggestion was made that the present inadequate representation of science in the Department of State can be remedied by the establishment of the Office of the Special Advisor in Science to the Secretary of State. The special advisor should be on a full-time basis and be available for consultation not only to the Secretary of State, but also to the Assistant Secretaries for the United Nations, for Economic Affairs, and for Public Affairs. To discharge his duties properly, the Special Advisor in Science should be provided with an adequate professional staff in Washington. In addition the committee attaches great importance to the assignment to embassies abroad of foreign service officers, or special scientific attachés with specific training in a branch of science but broad general scientific interests.

The committee expressed great interest in a suggestion made by Consumers Union of the United States, proposing a project to promote wider international exchange of information on techniques of consumer testing and a parallel program of consumer education. The committee voted to make a further study of these projects before submitting a definite proposal to the U. S. National Commission for Unesco.

Copies of the full texts of the various resolutions may be obtained from the chairman of the NRC Committee on Unesco, Bart J. Bok, Harvard Observatory, Cambridge 38, Massachusetts.

Deaths

William D. Webster, 65, instructor in zoology, University of Nebraska, died May 13 of a heart attack at Lincoln, Nebraska.

Arthur W. French, 80, professor emeritus of civil engineering at Worcester Polytechnic Institute, died at his home on May 27. Dr. French was a pioneer in the use of reinforced concrete.

Walter Elmer Ekblaw, 67, professor of geography at Clark University, died on June 5 at his home in North Grafton, Massachusetts. Dr. Ekblaw was associated from 1913 to 1917 with Donald MacMillan on the Crocker Land Expedition to the Arctic, and was a charter member of both the Explorers Club in New York and the Cosmos Club in Washington.

George Brewer, 46, physiologist, died June 12 at Doctors' Hospital, Washington, D. C. Dr. Brewer was a former professor of physiology at the medical schools of both Georgetown and George Washington Universities.

James Purves-Stewart, 79, neurologist, died in London on June 14. Sir James, who received his knighthood in 1918, is the author of *Diagnosis of nervous diseases.*

The Veterans Administration Hospital, Hines, Illinois, is looking for a biophysicist to take charge of a newly established neuropsychiatric laboratory in the research service. Applicants should have either a Ph.D. in biophysics or a Ph.D. in biochemistry with a minor in biophysics, and should be experienced in medical research. The beginning salary for the position is $6,235 a year, with periodic increases up to a maximum of $7,192.

Headquarters for the newly created **Uruguayan Association for the Advancement of Science** (Asociación Uruguaya para el Progreso de las Ciencias) have been established in Montevideo. The aims of the association include the development of all branches of science and the initiation of new, specialized subjects; the creation of scholarships for scientific research; a program of collaboration with the University of Montevideo to achieve the maximum development of its scientific research; liaison among scientific investigators working in the same or different fields; the securing of scientific investigators from other countries to work in Uruguay; and the maintenance of a clearing house for exchange of information with foreign institutions, particularly on scientific activities and publications.

Correspondence may be addressed to the president, Professor Clemente Estable, Instituto de Investigaciones en Ciencias Biológicas, Millán 4096, or to the secretary, Professor O. J. Maggiolo, Instituto de Máquinas, Facultad de Ingeniería, Cerrito 73, Montevideo, Uruguay.

Recently Received—

Chemical Production of Lactic Acid from Sugars by Rex Montgomery. Scientific Report Series No. 11. Copies available without charge from Sugar Research Foundation, Inc., 52 Wall Street, New York 5, N. Y.

Non-Linear Vibrations by Mary L. Cartwright. Reprinted from *The Advancement of Science,* April 1949. Available from the British Association for the Advancement of Science, Burlington House, London, W.1., England at 1/ld.

Prospecting for Uranium. Published by the Atomic Energy Commission and the U. S. Geological Survey. Available from the Supt. of Documents, U. S. Govt. Prntng. Office, Washington 25, D. C. at 30¢.

Notation on a Color System by Louis Cheskin. Available from Color Research Institute, Chicago 3, Illinois at 50¢.